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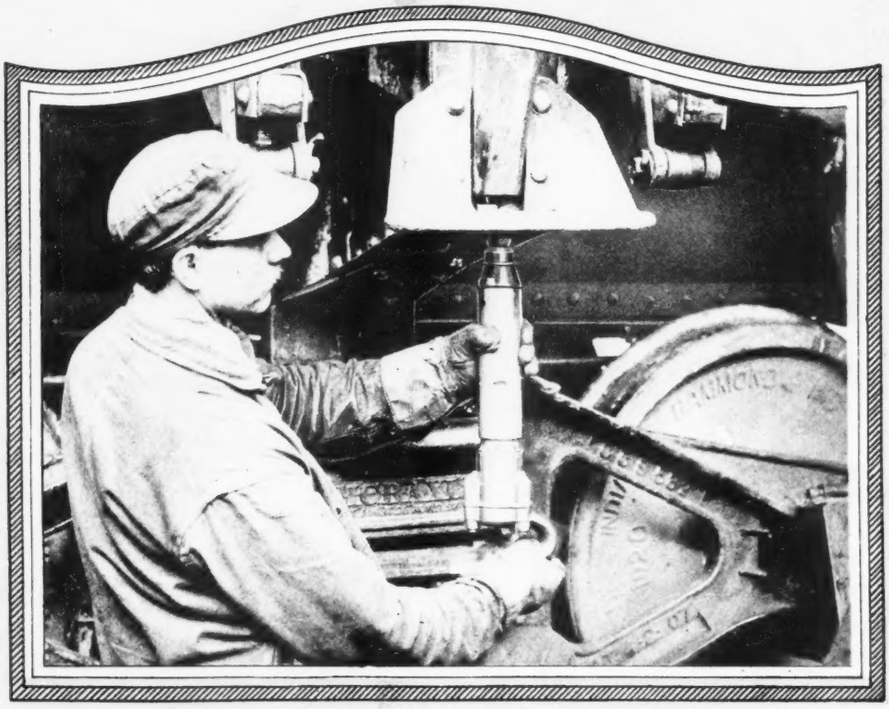

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Oil-Engine-Driven Towboat "Hustler"
Edward A. Edwards

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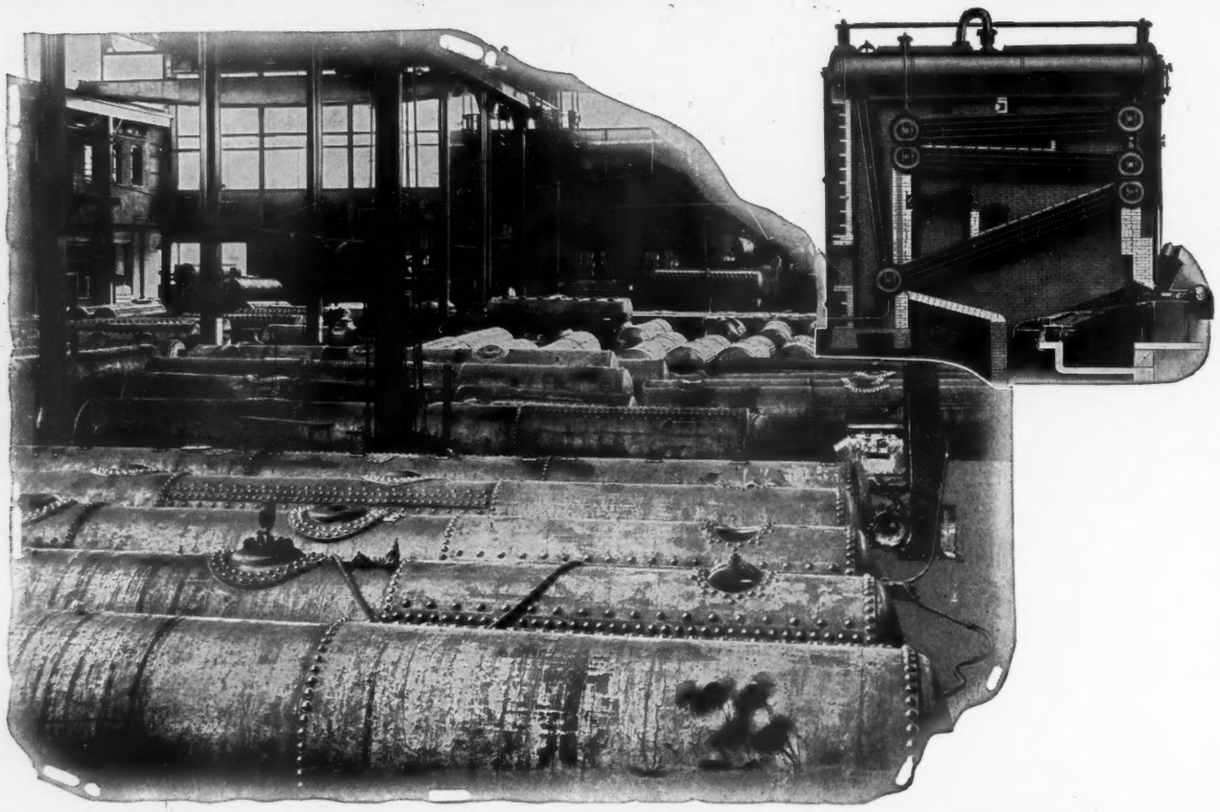

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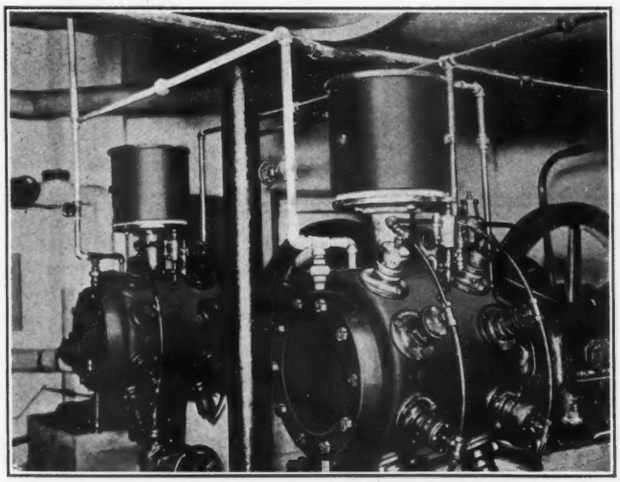

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DECEMBER, 1923

Growing Importance of Compressed Air in the Foundry

This Motive Medium and Pneumatic Tools Have Proved Very Effective in Speeding Up the Output of Acceptable Work

By ROBERT G. SKERRETT

THE FOUNDRY is one of the basic departments of the metal-working industries; and upon the efficient and the energetic operation of the country's foundries, large and small, depends a formidable array of other manufacturing activities. The general public, however, is not aware of the extent of this dependence, and yet in thousands of ways the populace benefits daily by this relationship.

As a matter of information, let it be said right here that there are close to 7,000 foundries in the United States; and in the course of a normal busy year their output attains an aggregate value of approximately $1,500,000,000. These figures, in themselves, indicate plainly the industrial importance of our foundries.

It is not our intention to detail just what the foundry means as a source of much that contributes continually to every walk of life and well-nigh every activity, but rather to bring out how essential it is that the foundry be able to meet the steadily increasing demands made upon it and to do this despite the fact that the artisan molder—the highly skilled foundryman, is becoming harder to find when he is needed most.

In latter years, the calling of the molder has not appealed to the apprentice as much as other fields of endeavor, and the ranks of this craft have, therefore, not expanded in proportion to the growth of the foundry business as a whole. Reluctance to enter the foundry has been a natural outcome of a wider and more general use of labor-saving devices in competing branches of industry. But this objection no longer holds, because recently there has been devised a variety of machines and appliances that have lightened tremendously foundry tasks and, incidentally, have made it possible for the molder and his associate workers to earn a good deal more in the course of a week than was formerly practicable.

The story we are going to tell covers the uses of compressed air and air-driven tools in a large iron foundry which has an output of about 1,000 tons of castings in the course of a month and which is operated in conjunction with the shops of a great machine-making company. This foundry has to produce castings of numerous sorts ranging all the way from a few ounces to more than 25 tons in weight, and the plant is therefore one that brings out impressively the gains to be realized by the many-sided applications of compressed air.

THE problem of the manufacturer today, no matter what his line, is to turn out marketable products in profitable quantities in a given time with the workers at his disposal. Existing conditions do not permit him to pick and to choose from the ranks of labor as he once could do—he must make the most of the men at hand.

This situation is especially true of foundries which are commonly considered less attractive to job hunters than many other branches of industry. Accordingly, the managers of plants of this sort are often hard put to it to operate to capacity and to produce thoroughly acceptable work at a reasonable cost.

Fortunately, the engineer and the inventor have come to the rescue; and between them they have evolved facilities that measurably offset the human handicap of an inadequate supply of qualified molders.

The accompanying article tells how compressed air and pneumatic tools make it possible for the skilled man to do more work without overtaxing himself and also how they enable the unskilled man to do much good work which he could not do without these up-to-date aids.

In order to avoid confusion, let us consider as far as possible the sequence of the different processes or stages involved in turning out a finished casting—finished from the foundry standpoint. And, further, to help us to a readier grasp of the subject, let us follow step by step the work, for example, of making a casting of a water-jacketed engine cylinder.

For the sake of those unfamiliar with the procedure in a foundry, we might contribute to a quicker understanding of the work if we state that all solid parts of a casting are represented by cavities in the sand mold, while hollow spaces in the casting are solid masses in the mold—the latter bodies being known to foundrymen as "cores" which generally call for much care and a certain amount of special treatment to make them fit for the ends they serve.

The cavities in a mold are formed by packing sand tightly around wooden or metal patterns, after which the patterns are removed. These patterns are commonly fashioned in two parts or sections split horizontally so that the upper and the lower divisions of a mold will each carry half of the impress. This arrangement facilitates the subsequent extraction of the pattern and renders it easy for the molder to examine the two halves of the impress and to give each whatever touches or attention may be necessary to make it perfect and to prepare it to withstand the weight and the intense heat to which it will be exposed when filled with molten metal. To hold his mold, the foundryman utilizes 2-part flasks or frames which, agreeably to the nature of the work in hand, may be constructed of wood or cast in iron or steel. The upper half of the flask or frame is termed the "cope," while the lower half is known as the "drag."

The molder begins his task by forming the lower half of his mold; and to do this he sets half of his engine-cylinder pattern inside and

Compressed air sprayer coating with blacking the surfaces of a complicated drag.

Using an air jet to blow dirt from a mold and a core just before lowering the cope.

at the bottom of a drag, successively shoveling sand into the drag and tamping that material firmly about the sides and the upturned surfaces of the pattern. Much depends upon the thoroughness with which this work is done, because any soft spots in the mass of the supporting sand might lead to movements that would deform the mold; cause the molten metal to flow in an undesirable manner; and thus produce a defective casting.

Depending upon the size of the casting, the molder uses either a pneumatic floor rammer or an air-driven bench rammer—the latter tool being best suited for the smaller classes of work. Under some conditions he may employ both of them on different parts of the same job. The point to be remembered is that these mechanical rammers deliver several hundred blows a minute, and in a given time they can pack the sand faster, harder, and more uniformly than is practicable with an ordinary hand rammer.

With the ramming of the drag finished, the bottom of the flask is turned uppermost, exposing the flat surface of the parting face of the pattern flush with the surrounding sand. This face is blown clean with a breath of compressed air, after which the cope half of the pattern is set in place upon the associate embedded pattern member. The parts are kept in alignment by a number of dowels or pins projecting from the face of one-half of the pattern and entering corresponding holes in the other half. The molder then dusts the upturned surfaces of the pattern and of the half-formed sand mold with what is known as "parting sand"—a very fine dry sand that serves to facilitate the subsequent separation of the cope and the drag when the cope has been duly filled with snugly packed sand.

So far so good. The next operation is that of setting a cope flask upon the drag for the purpose of completing the mold by also filling that portion of the flask with sand and ramming the sand in the manner already described. Inasmuch as the molten metal enters the mold at the proper time by way of the cope, which is uppermost, passages are now made in the sand by which the fluid iron can flow freely into the mold cavities and by which the gases generated during the pouring can readily escape to the atmosphere. These ducts are called sprues, gates, and risers—taking them in the order in which the molten metal enters them.

Having reached this stage of his work, the molder now lifts off the cope—taking care not to disturb the impression in the sand, inverts that half of the flask, extracts each half of the pattern, and gives whatever finishing touches may be needful to the mold surfaces. It should be self-evident that the raising and the inverting of the cope must be accomplished with the least possible vibration so as not to jar loose the sandy walls of the impress. This essential smoothness of motion can best be assured by utilizing an air hoist suited to this kind of work. An air hoist of this character is susceptible of extremely nice control; and in the foundry in question there are many hoists of this sort, each of them capable of handling loads up to five tons. Such a hoist can raise and lower a heavy body quickly and without jar, and do this in much shorter time than would be feasible with a chain hoist of equal capacity. The air hoist is superior to the electric hoist for foundry service because the air hoist is unaffected by heat and dust which might impair the electric apparatus; it is cheaper to maintain than the electric hoist; and it lends itself to a finer adjustment of speed. Any foundryman will appreciate these differences.

To stiffen the mold surfaces and to render that portion of the sand less likely to fuse when in contact with molten iron—in short, to insure a satisfactory and a smooth casting, it is customary to coat the mold imprint with a blacking compound composed of plumbago with an admixture of fire clay. The blacking, made fluid with water, may be brushed on or it may be sprayed on by means of a hand-operated atomizer. However, the work can be done better, faster, and at less cost by a compressed air apparatus which makes it possible for the molder to spread the blacking evenly not only upon readily accessible surfaces but also upon those which are rather hard to reach. Compressed air is likewise utilized to agitate the blacking and thus to maintain a uniform mixture.

Assuming that the nature and the size of the cylinder casting prohibit the use of a green-sand mold—one carrying a consider-

The pneumatic suction cleaner is the means by which sand and dirt can be gotten out of a mold when delicate handling is necessary to avoid doing damage.

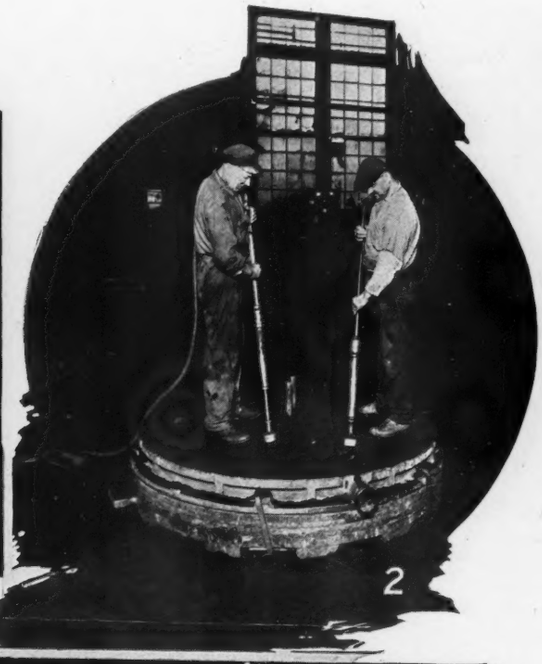
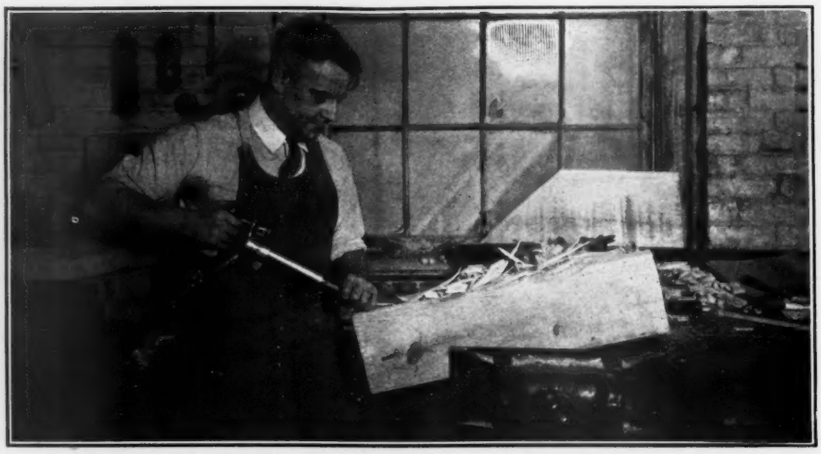


Fig. 1—Using the floor rammer on molds of 6-inch compressor beds. Where one man and a helper used to make two molds in a day, one molder and a helper now produce eight. Fig. 2—Pneumatic floor rammers speeding up the ramming of a flywheel mold. The air-driven tools make for better work and more of it in a given time. Fig. 3—The air-driven bench rammer is a handy tool which may be used with equal satisfaction in packing the sand firmly about either a large or a small pattern. Fig. 4—Bench rammer at work on core for segment of a flywheel. Cores of this kind must be packed tightly and evenly to insure their holding up against the molten iron. Fig. 5—A sizable job. Ramming sand about the pattern of a big 16-inch PRE compressor bed. The floor rammer delivers 600 blows a minute, and the workman has only to guide it. Fig. 6—A jarring machine in action. The blurred outlines of the mold and the bumper bed indicate the jolting action by which the sand is packed snugly about the hidden pattern.

able percentage of moisture, then the mold must be dried out. To effect this, the cope and the drag are placed on a suitable truck and run into an oil-fired furnace, where they are exposed for some hours to a temperature of 600°F. This hardens the mold and gets rid of moisture that might cause the development of disruptive steam pressures when the mold is being poured. The ovens which do this drying employ compressed air to atomize the fuel; and the compressed air enables the attendant to exercise perfect control over the combustion of the oil and the length of the flame.



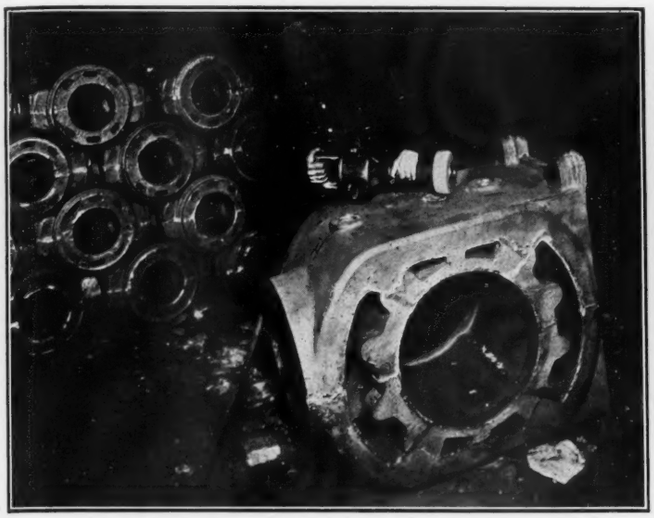
The pneumatic gouge has proved extremely useful in roughing out work in the pattern shop.

Should the mold be damaged and call for repairs after it has been dried out in the oven, the green sand necessarily used to make these repairs can be dried out and slightly baked in place by means of a torch burning oil atomized by compressed air. As a matter of fact, a torch of this sort is variously utilized in the foundry. For example, the torch is frequently employed in drying loam work—that is, molds formed right in the foundry floor; and the torch is also serviceable in starting cupola fires and in preheating ladles.

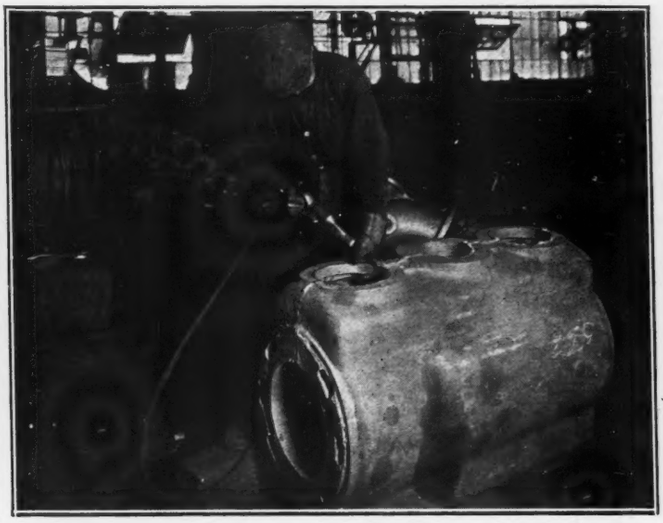
Up to this point, we have followed the making only of those parts of the mold which have to do directly with the solid walls or partitions of the engine cylinder in question. Now let us see how the hollow portions are taken care of. Here is where the core or cores come into play; and to see these in the forming we must go to the core department of the foundry. The cores are made by packing a special sand into metal or wooden molds, according to the work in hand. This sand carries a suitable binder—frequently an oil; and this ingredient tends to solidify or stiffen the core after baking so that the core can be handled to the needful extent when adjusting it in the 2-part mold preliminary to pouring. The cores are produced by pneumatically operated jarring machines which pack the sand by means of a vibratory motion; roll over and deposit the newly formed core on a bedplate; then lift off the mold slowly, vibrating it slightly to effect the desired separation; and, with this done, swing the mold back into position for refilling. Core making, when done by hand, is one of the fine arts of molding; but the air-driven machines which are now available for this service make it possible for virtually untrained labor to quickly become proficient in operating them.

There are various modifications of the pneumatic jarring machine, and some of these are designed especially for the forming of molds both by jolting and vibrating the sand-filled frames. Among these outfits are portable ones that can be readily moved from place to place on the foundry floor. Machines of the latter type are admirably adapted to produce

Left — A compressed-air-atomized oil burner in the rear wall of one of the core-baking and mold-drying ovens.
Right—The air-operated oil torch is used for various purposes in the foundry. Here we see it drying a loam job.
Bottom—Tapping one of the four 18-ton cupolas.



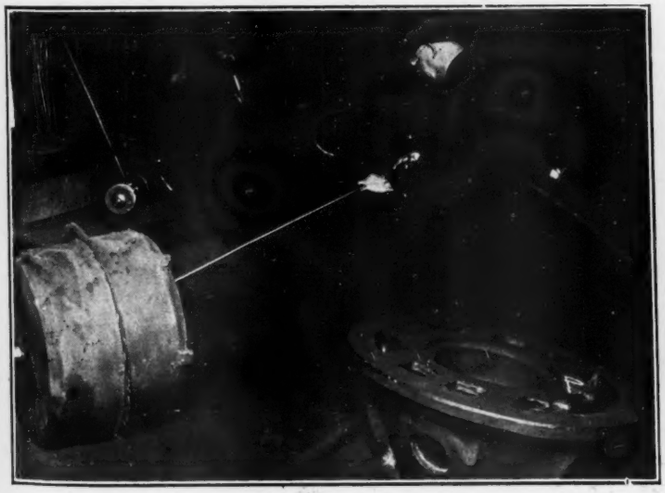
Smoothing off a cylinder jacket with a pneumatic grinder. This tool does its work well and rapidly.



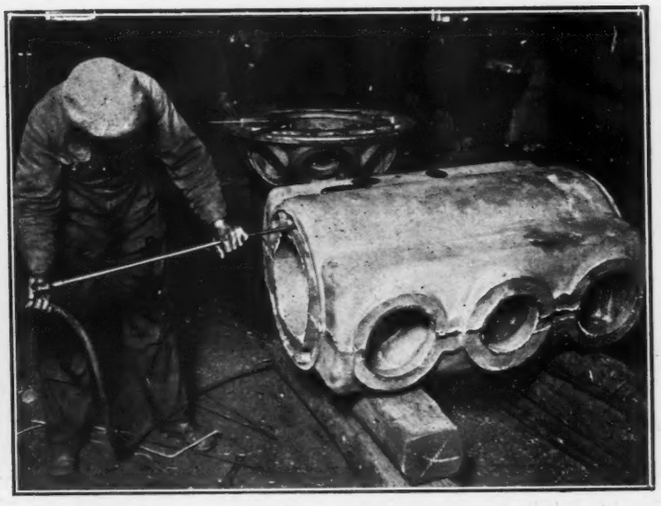
Getting rid of the fins on a cylinder casting by the aid of an air-driven chipping hammer.

Chipping excess metal from a belt wheel.

Chipping the bed of a 16-inch PRE compressor.

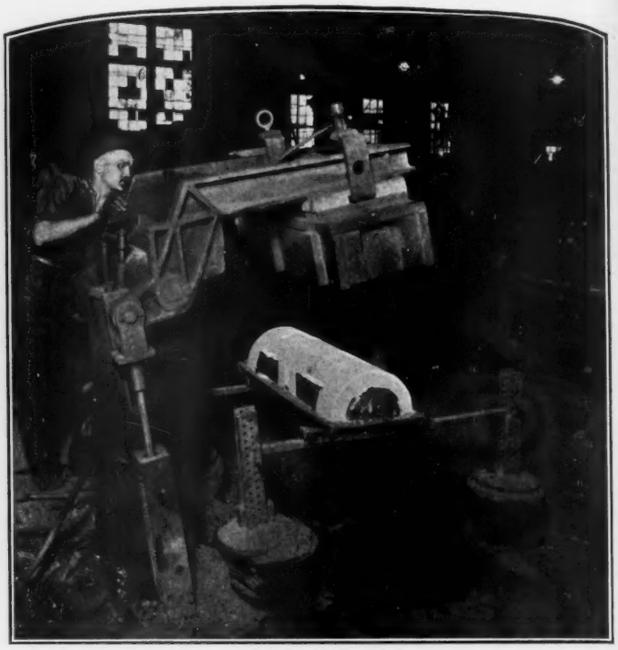


Blowing dirt out of a piston casting by means of a jet of compressed air.



The same handy tool blowing dirt out of a complicated cylinder casting.

An air-operated roll-over machine in the core-making department showing the mold being inverted preparatory to discharging a newly-formed core.



Here the roll-over machine has deposited a core and the mold is being returned to the filling position. Men of little experience operate these machines.

quickly molds for small castings. There is still another kind of jarring machine, also air operated, which imparts a rapid up-and-down movement to a metal platform or table large enough to carry a fairly big flask. This machine packs the sand about a pattern by bumping and settling actions. One of our illustrations shows a machine of this sort, in the foundry under consideration, bumping molds for compressor beds—a green-sand job thus lending itself to speedy duplication.

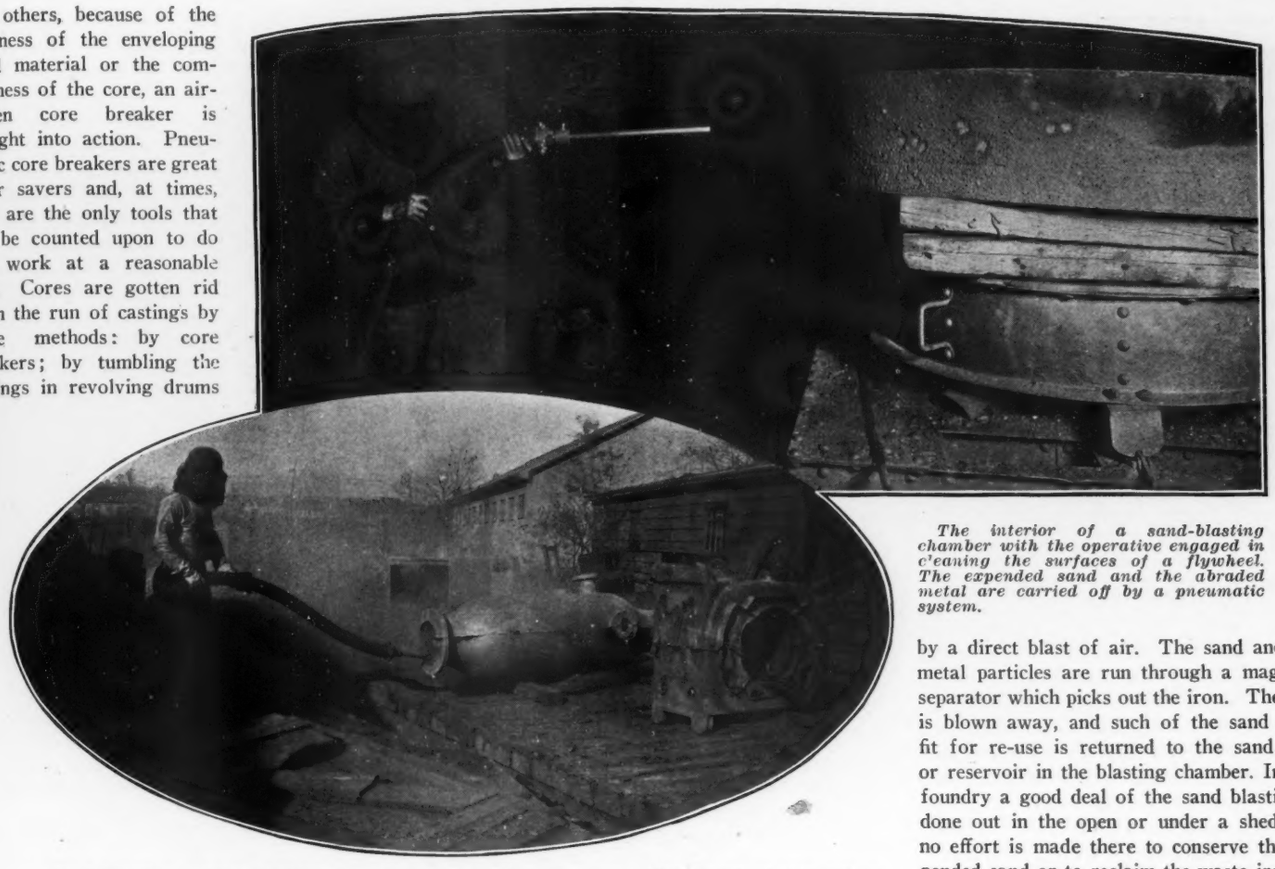
Small pneumatic molding machine forming cores for compressor valve seats.

Compressed air is extensively utilized for blowing out sand or dirt that may have gotten into the bottom of a mold after the core has been put in place and before closing down with the cope. Again, where the work has to be handled more delicately and where it is not desirable to remove foreign matter by a direct blast, the cleaning out can be done by suction through an induced draft caused by the siphoning effect of compressed air. We show such a suction cleaner at work clearing away sand that had fallen into a piston mold. An apparatus of this sort is peculiarly suited to dealing with rather complex molds and cores. Besides helping to make certain of a good casting, it is of material aid in speeding up output.

Shaking out, that is, removing castings from the mold or sand, is accomplished variously, depending upon the size of a casting. In some cases, this can be done effectually and economically by recourse to the pneumatic bumper or jolting machine; in others the work has to be performed entirely by hand; while in

Loading core wagons before running them into the oven. The cores are baked hard by exposing them for some hours to a temperature of from 500 to 600°F.

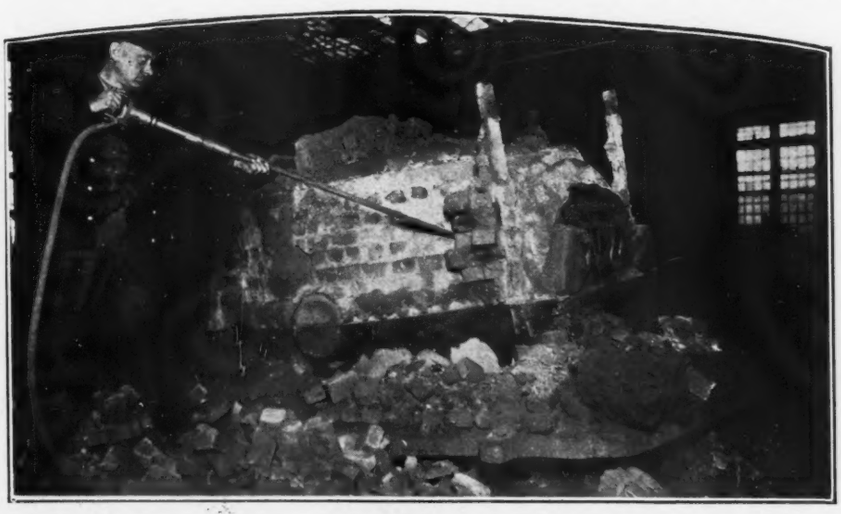
still others, because of the hardness of the enveloping mold material or the compactness of the core, an air-driven core breaker is brought into action. Pneumatic core breakers are great labor savers and, at times, they are the only tools that can be counted upon to do this work at a reasonable cost. Cores are gotten rid of in the run of castings by three methods: by core breakers; by tumbling the castings in revolving drums from which the dust is removed by suction; and by blowing out the shattered and the powdered cores by means of strong jets of compressed air.



Sand blasting a large condenser casting that is lying on a car. Much work of this sort is thus performed in the open.

We have now followed the procedure in the foundry from the making of the mold to the delivery of the casting in the chipping and cleaning department. As every one knows, and as some of our pictures plainly indicate, the rough casting is superficially marred by excess metal in the form of fins and attached sprues, gates, and risers, which have to be removed. Some of this metal can be detached by a hammer blow, but, to make a finished job, it is generally necessary to smooth off the surfaces—using air-driven chippers and pneumatic grinders to effect this. These tools have greatly reduced the time required to do this, and likewise turn out much better work. Indeed any foundry lacking equipment of this sort labors at a great disadvantage in these days of keen competition.

In addition to chippers and grinders, sand blasting is extensively relied upon in cleaning and surfacing castings of all sorts and sizes. A sand-blasting plant necessarily consumes much compressed air, and the source of supply must be ample. In this particular plant, compressed air serves to remove the expended sand and the abraded metal from the sand-blasting compartment. Compressed air is blown into a conveyer pipe line so as to induce a suction of sufficient strength to lift the sand and the particles of iron and then, at the proper point, to drive them onward by a direct blast of air. The sand and the metal particles are run through a magnetic separator which picks out the iron. The dust is blown away, and such of the sand as is fit for re-use is returned to the sand tank or reservoir in the blasting chamber. In this foundry a good deal of the sand blasting is done out in the open or under a shed, and no effort is made there to conserve the expended sand or to reclaim the waste iron.

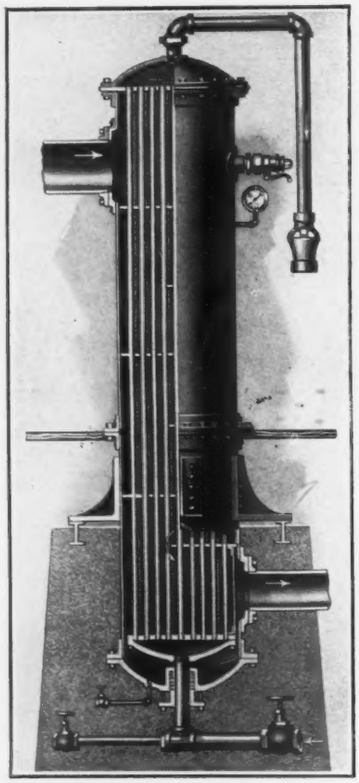


The core breaker has proved a valuable tool in clearing off brickwork and in getting out the hard cores of castings which otherwise would present a difficult problem to the foundryman.

The interior of a sand-blasting chamber with the operative engaged in cleaning the surfaces of a flywheel. The expended sand and the abraded metal are carried off by a pneumatic system.

In concluding our sketch of the diversified ways in which compressed air helps to save time, labor, and expense in the foundry, we might mention that a pneumatic gouge has also proved very valuable in roughing out work in the associate pattern shop. Further, inasmuch as the near-by pattern storeroom is unheated, the patterns are safeguarded against fire by what is known as a dry sprinkler system. In systems of this kind, the line is charged with compressed air interposed between the sprinklers and a check valve which holds the water back at a suitable point. This air is supplied and maintained at the proper pressure by any convenient compressor plant. The air, unlike water, will not freeze and rupture or block the piping when the temperature is low. Nevertheless, when the heat in the building reaches a point high enough to fuse and to open the sprinkler nozzles, then the air escapes, the pressure drops, the check valve is released, and the water is free to flow into the line and to do its work of fighting fire.

We should not forget to mention that compressed air is widely used throughout the foun-



Aftercoolers should be placed in the line to rid the air of moisture. Water in the distributing pipes may cause injurious water-hammer effects and lead to trouble in the pneumatic tools.

dry for cleaning the electric motors of traveling cranes; for cleaning patterns, cores, and molds; for dusting the clothes of the men when their day's work is done; and for many other kindred services. In the language of the superintendent of the plant: "Without compressed air we should be very seriously handicapped and quite incapable of doing all the work we now do, and do well."

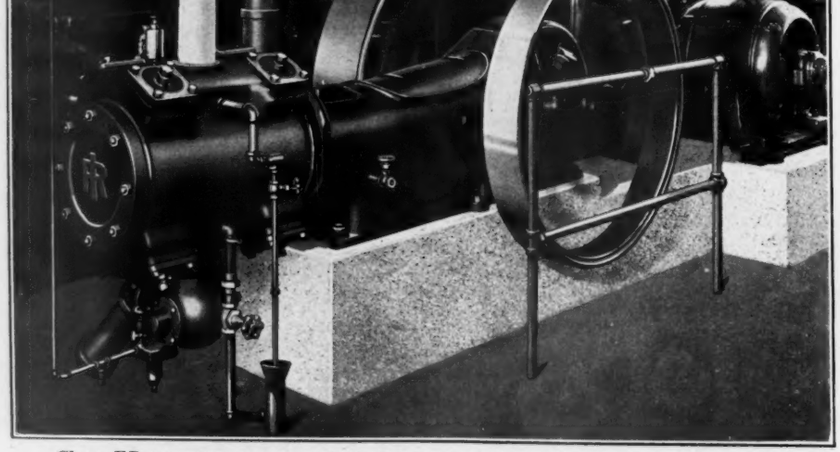
Perhaps on the latter point it might be desirable to be somewhat more specific. In this foundry 220 men are actually engaged in producing castings. Of these, 31½ per cent. do general labor; 38 per cent. prepare molds; and 30½ per cent. turn out cores. Among the molders and the core makers there are but 20 real mechanics who serve as leaders and who personally handle the most difficult of the jobs. The outstanding feature of this foundry is that most of the work is done by unskilled employees who, with the aid of compressed air and pneumatic tools, are able to do relatively high-grade work and to keep up production. In short, these men are actually excelling in performance skilled men elsewhere who have not compressed air and pneumatic tools at their disposal.

It is claimed by the management, and with good reason, that the foundry is doing fully 300 per cent. better than would be possible in the absence of the equipment mentioned. Further, the men, who are for the most part employed on a piece-work basis, make anywhere from 20 to 50 per cent. over and above their hourly rate. In short, operating conditions contribute to the satisfaction of everybody concerned. This is saying a great deal under existing circumstances.

Finally, it is only fitting that some mention should be made of the compressors which logically constitute an important part of an air-equipped foundry. Compressors for service in this field must be especially suited to the atmosphere or environment in which they have to work; and the operative economy of such a plant and its general success will hinge largely upon a wise choice of compressors. The type should be simple, sturdy and efficient. All working parts should be enclosed and lubricated automatically. In short, the machine should be built on the so-called "take-care-of-itself" principle, which will insure the purchaser a thoroughly dependable compressor.

Lowering a heavy core into a mold by means of an air hoist. A job of this sort calls for very careful handling.

There were produced in 1922 over 430,000,000 pounds of commercial explosives, most of which was handled by the railroads of the United States without a single accident. The Bureau of Explosives very properly calls attention to the record to which it largely contributed.



Class ER compressors are notable because of their simple and sturdy construction and their proved efficiency in foundry service.

GROWTH OF THE ICE-CREAM HABIT IN ENGLAND

THE ice-cream and soda-fountain trade might be considered Great Britain's newest industry; and the women of the country are responsible for the increase in the consumption of carbonated drinks, etc. The first fountain was introduced in England twelve years ago, but was really installed to attract American tourists during the summer months. However, enterprising concerns were not slow to grasp the opportunity offered by this side line; and during 1921 and 1922 one large company, with a chain of confectionery and tea shops in all the principal cities and towns, equipped its establishments with soda fountains and began advertising the all-year-round value of ice cream as a food-stuff.

So successful was the venture that small, independent confectioners and caterers have followed suit; and in London, especially, the soft-drink and ice-cream habit is growing. Last year, 3,000 soda fountains were installed throughout Great Britain, and fully half of these were of American manufacture.

Canada's Great Asbestos Industry

The Dominion Now Supplies Fully 80 Per Cent. of All the Asbestos Consumed the World Over

PART II

By NORMAN R. FISHER

IN THE PRECEDING installment of this article we told something about the geological origin and the general nature of asbestos, and, likewise, described the different methods employed in mining the mineral and in handling it before it is subjected to the milling processes. We shall now take up the operations by which the asbestos is freed from the enveloping rock and graded ready for the market.

As previously explained, the most valuable of the recovered asbestos is that known as crude, which is merely the vein matter in its natural state separated as cleanly and with as little bruising as possible from the mother rock. The veins in which it is found vary from a fraction of an inch to six or seven inches wide but are seldom much over three inches; and only those fibers that are half an inch or more in length are collected to be sold as crude—anything much shorter being of little use for spinning, to which purpose this class of material is mainly put.

The crude asbestos is collected by hand picking and cobbing at various stages in the mining operations and, after being dried, is carefully overhauled by boys and girls under expert supervision in order to properly clean and to sort it into the different grades desired for the market. At present only two grades of crude are produced, and these are commonly known as No. 1 and No. 2. No. 1 is the select of the material, and measures half an inch or more in length, while No. 2 is what remains of the discard after all rock and foreign matter have been removed and the asbestos has been screened over a 4-mesh screen to get rid of the shorts.

The yield of crude per ton of rock mined varies considerably throughout the district in general and even at different points in a particular mine. The recovery from the richer patches or zones that are uncovered every now and then in the deposit, is, of course, abnormally high, but, as a whole, it averages from about 15 to 25 per cent. at the regularly producing properties, such as those in the Thetford area.

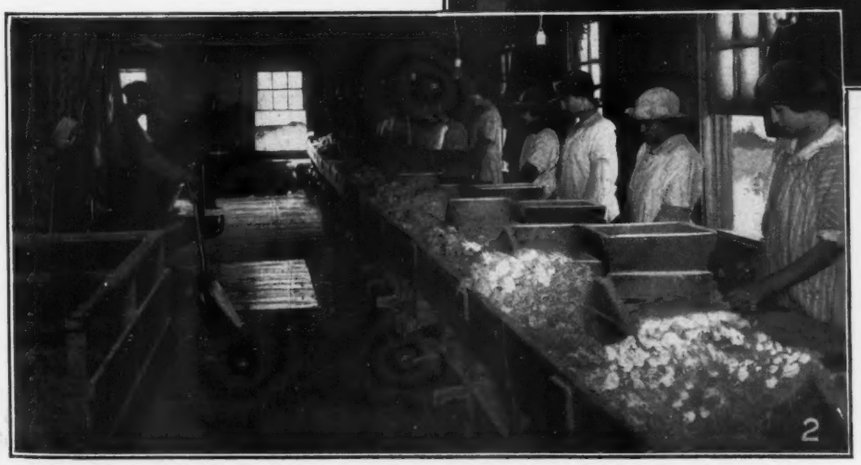
The object of the milling is to liberate by mechanical means, and with the least possible breakage and bruising, as much as practicable of the asbestos content of the rock that could not be readily removed by hand. When mechanical recovery of asbestos was first attempted, the broken rock with its liberated fiber content was merely dropped through a blast of air which blew the fiber into receiving bins provided for the purpose. But this process, because of its many deficiencies and disadvantages, was soon discarded and replaced by one of suction and collection in separators similar to that now in use, though on a much more elaborate scale.

The procedure in all the mills is more or less the same, varying only in detail and in method of application, and may, for the purpose of this article, be conveniently classified under the following heads: coarse crushing; drying; fine crushing and fiberizing; extracting of the fiber; and grading.

The primary crushers used throughout the field vary considerably in size, and the choice depends not only on their capacity but on the method of mining practiced at any particular property. It is the latter that regulates the size of the rock to be delivered to the crushers. Where, for instance, shovels with large-capacity buckets are in service, it is found desirable to use crushers capable of taking care of fairly big pieces of rock in order to save the trouble and the expense of blockholing them in the mine workings. In one case, for example, a 48x36-inch crusher of the jaw type is in operation, while in another, one of 36x48 inches is found adequate. But the crusher in most common use in the district is that 24x36 inches in size. The jaw type is generally preferred for primary crushing—only one or two gyratory breakers being employed throughout the field.

It is the practice in one of the mines to convey the primary-crusher product over picking belts so as to remove whatever loose crude, barren rock, or foreign matter it might contain before passing it along to the secondary crushers; but in all other mines it goes directly from the primary into the secondary crushers. The secondary crushing equipment varies considerably from mine to mine: some operate

The broken asbestos-bearing rock is carried by a traveling belt to pickers who remove as much as possible of the barren rock, foreign matter, and loose crude before the material is passed on to secondary crushers.



Cobbing and sorting the crude asbestos for marketing. The operatives become skilful in doing this work.

corrugated rolls; some have jaw crushers; others use gyratory breakers, while still others employ a combination of these machines. But all of them work toward a common end—that is, the breaking down of the rock, in preparation for its drying, to the desired size of about two inches.

Many different types of driers have been tried out since the inception of the milling practice in the industry; but most of them were subsequently discarded. Now, a direct-heat,

General view of grading tables in an asbestos mill. Here it is that the asbestos fibers are graded to meet manufacturing requirements.

single-shell, rotary type—with forced draft under the fire box—is generally favored. Usually the fire box is located at the ore charging end of the drier, but sometimes it is at the discharge end so that the gradually drying ore flows toward the fire instead of away from it as it does in the former case.

Some of the largest operators prefer the return-current, internal-tube rotary type equipped for both forced and induced draft, and some very large installations of this kind are in service, while others use a special, stationary, vertical type. The feed, in the case of the latter, is raised to the top of the drying shaft by elevators, whence gravity carries it downward over baffles to the bottom against ascending currents of hot air. Apart from their respective advantages and disadvantages from an operating point of view, the choice of any of the types of driers mentioned must be considered in the light of the class of ore to be handled as well as the sought-for condition of the ore at the end of the drying process.

After it is dried, the material is conveyed directly to the mill for the extraction of its fiber content or delivered to storage bins ahead, where it is kept in readiness to be drawn upon as required. Ample storage facilities between the mine and the mill are, of course, desirable in any kind of mining operation; but under the conditions obtaining here, where the mines are subject to protracted interruptions on account of inclement weather, such a provision is essential. For this reason, most of the mines have storage bins of unusually large capacity —one of them being able to hold as much as 20,000 tons of dried rock in reserve at a time.

Courtesy Rockbestos Products Corp.

Carding fluffy asbestos preparatory to working it into an insulating cover for electric conductors.

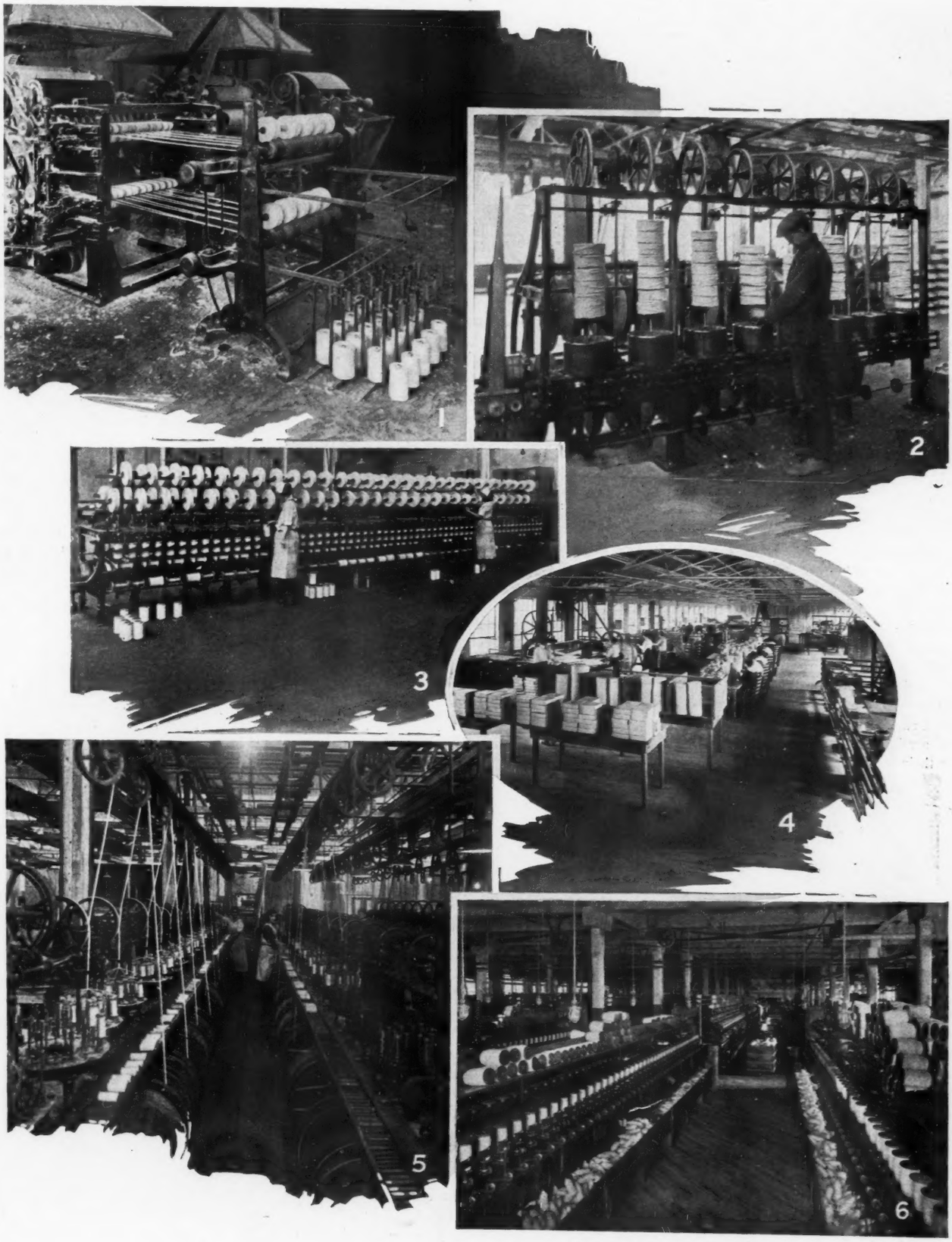
Once the dried material arrives at the mill proper, the process begins which frees it of its fiber content. Fiber already separated from the rock at this stage is first of all removed by one of the usual suction methods provided for the purpose, and the cleaned rock is then passed to suitable comminuting and fiberizing machines to release whatever fiber still remains in more intimate association with it.

It is the practice in some mills first to treat the asbestos rock in crushing machines and then to convey it into one of the many types of fiberizing machines available, while in others both the breaking and the fiberizing are done concurrently in machines designed especially for the dual work. In the case of the former, gyratory breakers, disk crushers, rolls, or a combination of all these is used to break down the rock to the undersize of about one inch, and this material is then passed into one of the different fiberizing machines, such as cyclones, jumbos, etc. In the latter case, however, the broken rock goes directly to hammer crushers, equipped either with or without sizing grids, in which, as already mentioned, the crushing and the fiberizing are done simultaneously.

The resultant product of the two methods just described is passed in front of suckers to remove from it its freed fiber content, and the discard is again put into cyclones or jumbos or both for further treatment to separate the still remaining fiber, which is then recovered, as usual, by suction. The removal of the fiber by suction is, in each instance, facilitated by conveying the crushed rock with its fiberized asbestos content over screens or through specially designed gravity apparatus; and the fiber thus separated is next collected in what are known as collectors, in which the centrifugal force, induced by the rapidly moving current of asbestos-laden air, is made use of to precipitate the fiber. The fiber recovery varies considerably from mine to mine and depends not only on the class of rock being treated but also on the grading practices. Individually, it ranges from 3 to 15 per cent. and more, but collectively the general average is around 5 per cent. of the rock mined and 6 per cent. of the rock milled.

The fiber thus collected is then treated on shaking or rotating screens, called graders, to separate it into the different lengths or grades desired by the manufacturer. This grading is regulated by what is known as a testing machine, an instrument locally evolved for the purpose and now generally adopted. It consists of a nest of three trays or boxes, the top one of which is provided with a screen having a half-inch opening; the middle one with a 4-mesh screen; and the bottom one with a 10-mesh screen. All are so fixed in the machine that they can be shaken as one, with a horizontal stroke of 1½ inches, at a rate of 300 movements per minute for two minutes—when the machine automatically comes to a stop.

To test the grading of any fiber, sixteen ounces of that fiber are placed on the top tray and shaken in the machine for the 2-minute period. The quantity that remains on each screen is next weighed separately to conclude



Courtesy of Rockbestos Products Corp. and of B Marcuse.

Fig. 1—Here the carded asbestos is worked into what is known as "roving." Fig. 2—Serving or winding rubber-covered electrical conductors with asbestos to protect them from heat. Fig. 3—Twisting machine which converts asbestos roving into asbestos yarn. Fig. 4—Cutting and packing asbestos mats for table service. Fig. 5—Braiding electrical conductors with asbestos yarn. Fig. 6—One of the stages in the manufacture of asbestos brake lining for automobiles.

How suction is applied at one stage of the process by which asbestos fiber is separated from the rock.

the test. Though special grades calling for unusual tests may be prepared at different mills to meet certain manufacturing requirements, the fiber mostly comes in recognized grades of a more or less standard test.

The grades produced at each mine are known by distinctive markings—qualified by the name of the company using them—such as X, Z, XX, and C for materials having base tests of 8-6-2, 1½-9½-5, 10-6, and 5-11, respectively, though in practice the actual tests might vary considerably from these. Unfortunately, there is no common method of marking—the same grade from different mines not necessarily being known by the same marking. As is often the case, one mine may use the marking of another mine but for an entirely different class of fiber—a practice that occasionally leads to much confusion.

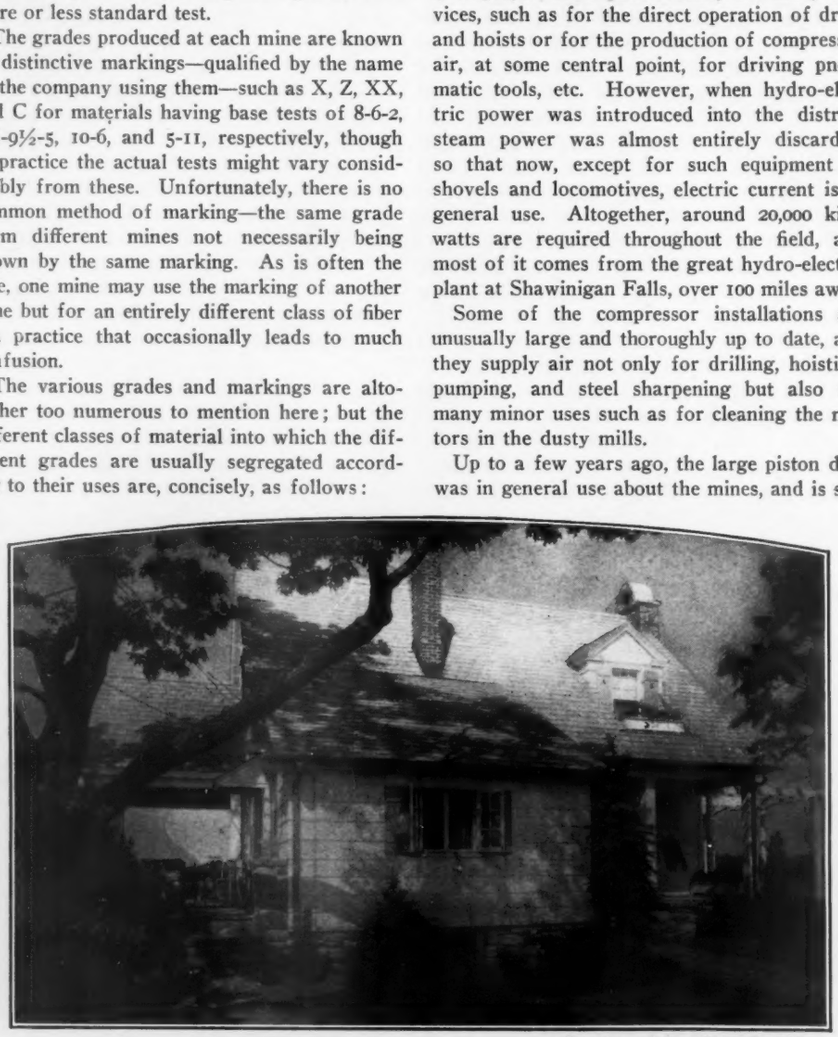
The various grades and markings are altogether too numerous to mention here; but the different classes of material into which the different grades are usually segregated according to their uses are, concisely, as follows:

Class	Base Test
Spinning stock .....No. 1	4-7 - 4 - 1
No. 2	2-8 - 4 - 2
Magnesia and compressed sheet stock	0-8 - 6 - 2
Shingle stock	0-1½- 9½- 5
Paper stock	0-0 -10 - 6
Cement and roofing stock	0-0 - 5 -11
Asbestic	No test.

In the first 25 or more years of the industry's career, steam was in common use for power purposes around the mines and was still widely employed until quite recently for many services, such as for the direct operation of drills and hoists or for the production of compressed air, at some central point, for driving pneumatic tools, etc. However, when hydro-electric power was introduced into the district, steam power was almost entirely discarded, so that now, except for such equipment as shovels and locomotives, electric current is in general use. Altogether, around 20,000 kilowatts are required throughout the field, and most of it comes from the great hydro-electric plant at Shawinigan Falls, over 100 miles away.

Some of the compressor installations are unusually large and thoroughly up to date, and they supply air not only for drilling, hoisting, pumping, and steel sharpening but also for many minor uses such as for cleaning the motors in the dusty mills.

Up to a few years ago, the large piston drill was in general use about the mines, and is still preferred by some operators for certain purposes, but this machine is now for the most part replaced by the more economical hammer type of drill which is employed for all classes of the mining work, from benching and stoping down to blockholing.



Courtesy Johns-Manville, Inc.

The asbestos shingle is proving its worth as a roofing material because of its beauty and its durability.

CARBON MONOXIDE IN TOBACCO SMOKE

TESTS conducted by the Bureau of Mines indicate that carbon-monoxide hazard from smoking indoors or in mines is negligible, in itself, though it may cumulatively add to the smoker's danger if he be caught by carbon monoxide from other sources, such as may arise in the mining industry.

The tests referred to were made on three men who were confined in a closed chamber having a capacity of 1,000 cubic feet. The subjects puffed for an hour and a half at cigarettes of every variety. Turkish, Egyptian, the old Virginia brand, and the other type where the smoker "rolls his own." Following this, the smokers drew away at all sorts of cigars—cheroots, Pittsburgh stogies, black Manilas, and choice Havanas. Finally, they puffed at pipes—pipes of clay and of cob, pipes of meerschaum and of briar.

At the conclusion of the performance the air in the closed chamber had become so smoky that it was impossible to see across the room. The atmosphere was so irritating to the eyes that it was necessary to wear goggles. Samples of the atmosphere and of the blood of the smokers were then taken for analysis. It was found that in no case did the carbon monoxide of the air exceed 1/100 per cent. The maximum blood saturation was 5 per cent.

NEW PROTECTIVE PAINT

A DIFFICULT and a persistent problem confronting industrial engineers is to efficiently protect their work after completion—and suitable paint for this purpose is most important and perplexing. The ideal paint should prevent rusting, resist acid corrosion and, at the same time, withstand the action of heat. Steel chimneys are especially discouraging—the temperatures often going to 500 or 600°F. at the base and causing paints to shrivel up and to give changing weather conditions every opportunity to do damage.

It is announced that there is being developed in England a remarkable new paint of great promise. It is said to consist essentially of finely divided carbon and of complex organic carbon compounds in a peculiar greasy and colloidal state, which is brought about by the action of sulphuric acid on coal tar.

This paint, black only, is claimed to have the most unusual properties, being absolutely unaffected by temperatures up to 800°F., inasmuch as the carbon does not oxidize because of its peculiar physical condition. It is also claimed that the paint is resistant to all acids, even when they are comparatively strong; to alkalis; to all obnoxious gases; and to solvents such as alcohol, benzol, and petrol.

On the Great Western Railway of England there is now a scheduled train which regularly makes the distance between Paddington and Swindon, 77¼ miles, in 75 minutes—an average speed of 61.6 miles per hour. On the London & North Eastern Railway there are two shorter runs, 44 miles and 22½ miles, which are made at a speed of 61.5 miles an hour.

Oil-Engine-Driven Towboat "Hustler"

The Excellent Service Performances of this New Craft Have Proved Something of a Revelation to the Shipping Fraternity

By EDWARD A. EDWARDS*

ONE OF THE most interesting and important motor vessels yet constructed in the United States is the motor tug *Hustler*, designed by the writer for the Diamond P. Transportation Company of Philadelphia, and completed the latter part of August at the yard of the Clinton Shipbuilding & Repair Company, likewise of Philadelphia.

The vessel is the first of her kind in the country planned to be built throughout of steel and in accordance with the most successful modern motorship practice. For this reason she is being watched with much interest by all towboat operators, and if she keeps up the performance shown in her first two months of service—which has surpassed the highest expectations of her owners—she will doubtless be the forerunner of many other vessels of the same type.

The *Hustler* was designed for general inland and coastwise towing—her principal work being the moving of from one to three sand barges, of 800 tons dead-weight capacity, up and down the length of Delaware Bay with occasional outside trips to New York and New England points. The owners decided that 300 H.P. was the minimum to efficiently perform this work, and, therefore, the dimensions of the hull were made to accommodate an oil engine of that size, together with the necessary auxiliaries and a bunker capacity of at least a month's supply of fuel. The draft was made about two feet less than would ordinarily be desirable, especially for strictly sea-going service; but it is also necessary for the vessel to reach certain bay and river points, where the depth of water is limited, and to navigate canals at times.

THE TOWBOAT is the dray horse of water transportation. In its way it is superior to its land counterpart, for the latter is being largely supplanted by the power-driven vehicle while the tug becomes more and more useful as time goes on.

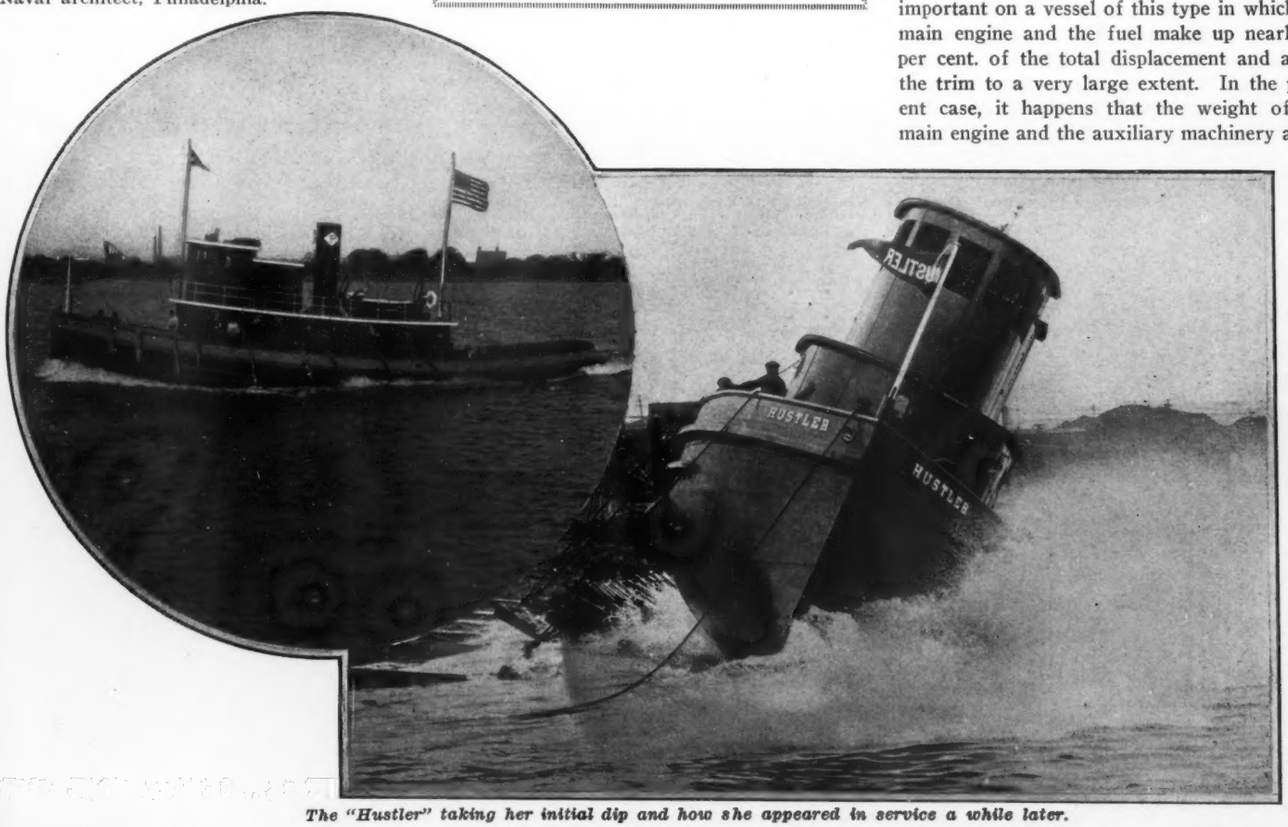
Out of our total tonnage, that of our towboats may not be conspicuous; but when we consider their number we see how much there must be for them to do in shifting other craft that are either temporarily or always incapable of propelling themselves.

In short, the tug is the handy beast of burden among shipping; and any advance in its construction and equipment should be of interest to the maritime fraternity. The present article describes a notable step forward in marine engineering.

The design shows a fairly full-bodied hull which has a good dead rise at the midship section and a minimum displacement consistent with ample freeboard and the weight to be carried. The after waterlines are not carried out as fine as might be desirable for fast running, but as the boat is intended primarily for towing conditions, involving a speed of around six knots, the ends were made short to cut down the overall length and the first cost. The forward sections have been given a good flare, which tends to prevent diving and shipping water in a heavy sea and, at the same time, gives increased deck room. A high sheer and a minimum freeboard of about fifteen inches when fully bunkered are additional features of seaworthiness, and will make for comfort and safety when the boat is on coastwise trips.

The fore-and-aft distribution of weights is important on a vessel of this type in which the main engine and the fuel make up nearly 50 per cent. of the total displacement and affect the trim to a very large extent. In the present case, it happens that the weight of the main engine and the auxiliary machinery about

*Naval architect, Philadelphia.



The "Hustler" taking her initial dip and how she appeared in service a while later.

equal the weight of the fuel, and, therefore, were so placed as to provide approximately equal moments forward and aft of the center of buoyancy. As the fuel is used up, the forward moment of course decreases and the bow comes up, but this may be offset by pumping water into the forepeak tank which has a capacity of eleven tons—a weight sufficient, at its distance from the center of buoyancy, to keep the ship evenly trimmed until over 80 per cent. of the fuel is consumed.

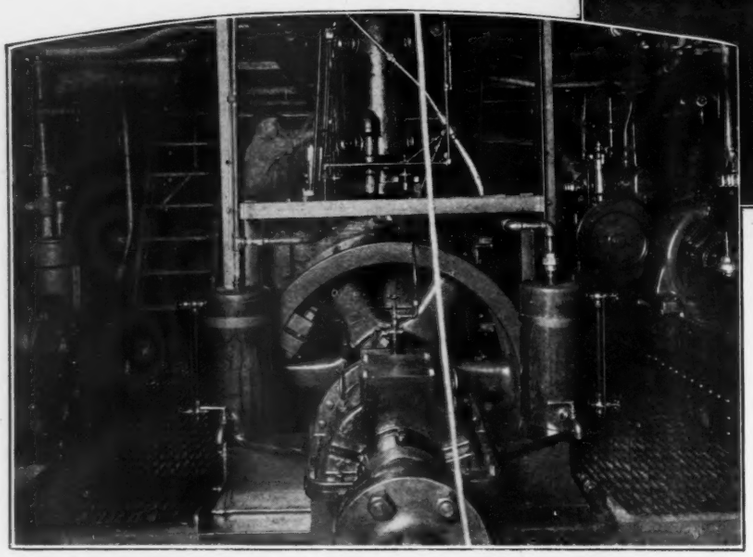
The construction of the *Hustler* is somewhat heavier than would actually be required by the American Bureau of Shipping or Lloyds for a steel vessel of this size, because it has been found that strict adherence to classification-society rules makes a hull too light for the rough work usually encountered by the average towboat. The minimum weight of shell plating is 12.5 pounds ($^{5}/_{16}$ inch), while the garboard strakes are 15 pounds (⅜ inch), as are likewise all plates at the bow which would come in contact with ice in winter running. The forward part of the shell is further strengthened against ice pressure by intermediate frames extending well aft from the stem. The forward frames are also backed up by three sets of longitudinal stringers on each side. All shell seams in wake of the fuel bunker are double riveted. Frames are of 3x2½-inch x 5.6-pound ($^{5}/_{16}$ inch) angles, spaced 20 inches center to center, with 2½x2½-inch x 4.1-pound (¼ inch) reverse bars carried well up beyond the turn of the bilge and doubled in way of main engine bed.

There are two oiltight bulkheads on frames 15 to 21, forming the fuel bunker, and two watertight bulkheads at the peaks. The construction in general follows standard practice and presents no unusual features. The stern tube and the tail shaft are fitted with the McNab-Vickers lubricating appliance by which the tube is kept filled with heavy oil; and it is expected that this will greatly lengthen the life of the stern bearing and the shaft sleeves. One important advantage gained over the average steam tug of this size and power is the possibility of placing the main towing bitt nearly one-third the vessel's length forward of the stern, a feature which greatly facilitates handling and steering with a heavy tow behind.

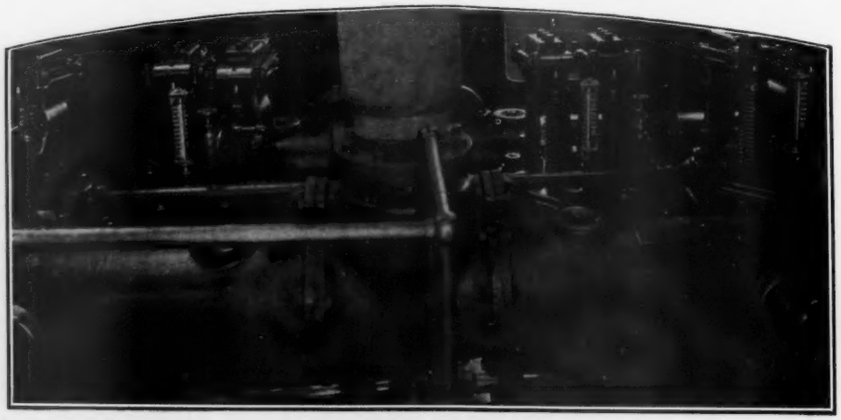
Much time and thought were given to the selection and the arrangement of the machinery. It was decided first of all to follow the practice of the most successful and economical motorships and to use electric auxiliaries throughout. The main and the auxiliary engines were chosen after careful investigation of practically everything that the market afforded; and inasmuch as virtually none of the makers of 300-H.P. engines, suitable for the main propelling unit, manufactures a small oil-engine-driven generating set it was necessary to have the latter of a different make and type from the former. It is to be regretted that all marine-oil engine builders do not see the wisdom of turning out suitable, small auxiliary units to go with every installation, as it would undoubtedly assist them in making the sale in the first place; would simplify planning and installing; and would insure a more uniformly efficient and satisfactory machinery layout with undivided responsibility for successful operation.

After an inspection, under operating conditions, of several makes of both the full Diesel and the surface ignition types of engines, one was finally selected which belongs, strictly speaking, to neither class but which seemed to a large extent to combine the advantages of both and to avoid their defects. This engine, manufactured by the Ingersoll-Rand Company, is a 4-cycle, moderate-compression type, with solid or mechanical injection, using the Price combustion-head system of opposed sprays. It is a 6-cylinder machine with 13-inch bore and 19-inch stroke, and is rated at 320 B.H.P. at 250 R.P.M. The engine has the mechanical simplicity of the semi-Diesel or surface ignition type—requiring no high-pres-

Near view from the side of the main engine showing pumps, distributor, and maneuvering lever.



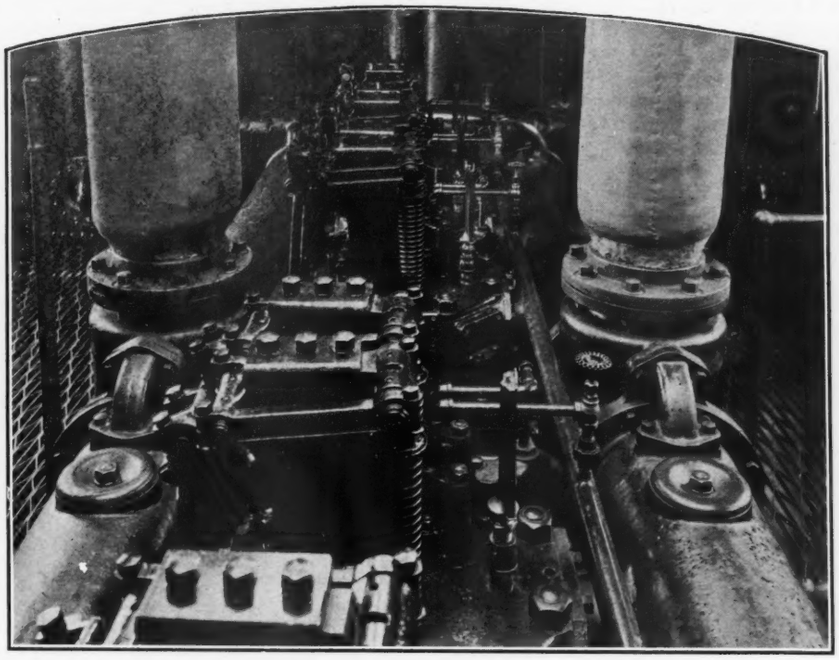
After end of the main engine, with Kingsbury thrust bearing in the foreground. At right are the two auxiliary generator sets. At left is seen the short-belt-driven Ingersoll-Rand compressor.



Close-up of the mechanism of some of the valves.

sure air blast, with its accompanying complication of 3-stage air compressor, and no shifting of camshaft for reversing. At the same time, it is practically as economical in fuel consumption as any high-compression air-blast type. Furthermore, it starts cold without the use of electric plugs or other ignition devices in the combustion chambers.

The method of reversing is unique, and not found on any other engine. The timing of the exhaust and the inlet valves and of the fuel injection is symmetrical with respect to the top and bottom dead centers so that the engine will run equally well in either direction without any mechanical changes whatever—it is necessary simply to start it ahead or astern as desired. There is a manifold on each side and two exhaust or inlet pipes. When running ahead, one set of valves and one manifold with its pipe carry out the exhaust gases, while the other manifold acts as an air intake. When running astern, the functions of the valves, manifolds and pipes are reversed—those previously acting as intakes then serving as exhausts, and the exhausts as intakes. This system works perfectly due to the clean combustion of the fuel; adds no extra parts; and enables the entire control as well as the reversing of the engine to be centered in a single lever. It also makes it a simple matter to arrange a duplicate control station above the engine-room grating, which was done in the present case, thus enabling the engineer to maneuver the engine from the upper engine-room where he can see out through the doors on either side of the house.

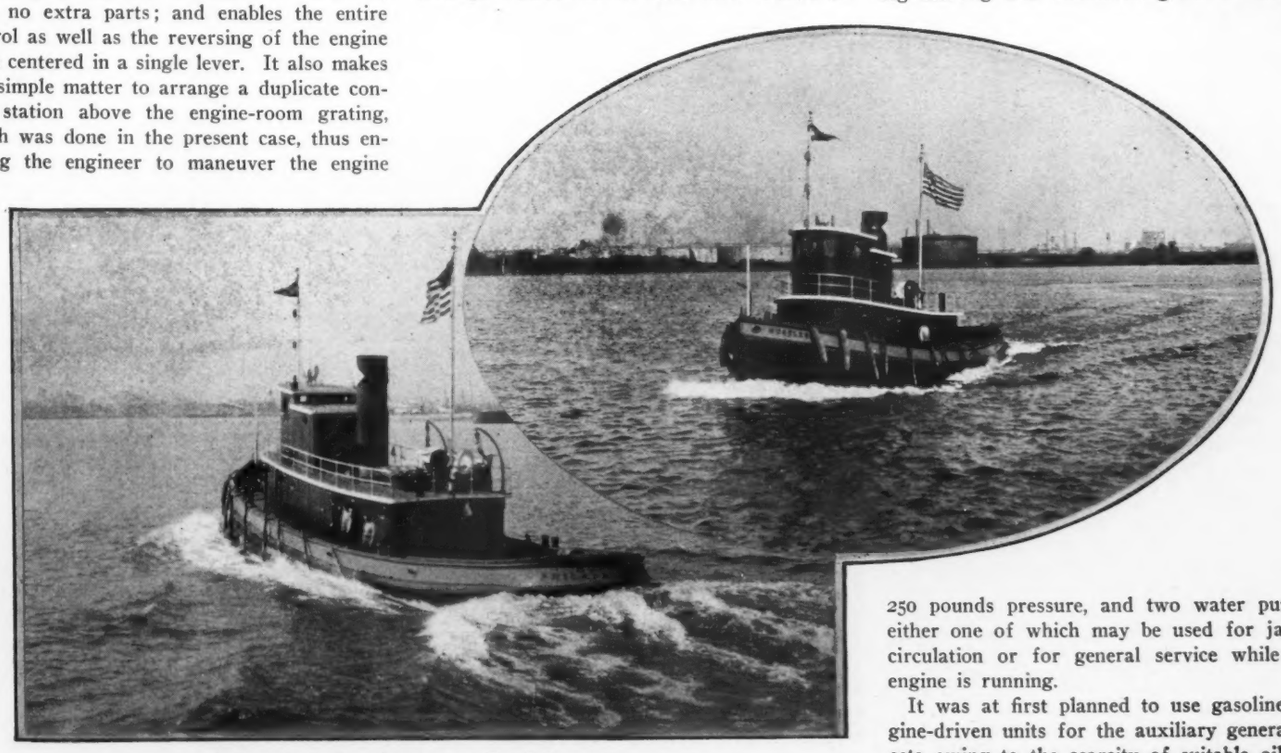


Fore-and-aft view of the top of the main oil engine.

Lubrication is especially thorough, and is a combination of pressure-feed, gravity-feed, and splash systems—important bearings receiving oil by all three methods. There are two lubricating oil pumps operated from the crankshaft extension at the forward end of the engine, one of which maintains the pressure-feed circulation and the other the gravity feed through a Richardson-Phenix filter located on the upper engine-room grating. The oil from the cylinder walls, where it encounters the worst conditions as to heat, carbon, etc., is not returned to the crank case and recirculated with the general system, but is drawn off separately into a small tank and may be thrown out from time to time instead of being put through the filter. Fresh oil replaces that discarded. The engine has two main fuel pumps, each supplying a group of three cylinders through a distributor.

The valve gear is very quiet in operation—the push rods being worked by eccentrics, on the side shaft, located inside the crank-case housing; and the valves, themselves, instead of having the usual rocker arms, are actuated by a roller-path motion which gives them a uniformly accelerated opening with the greatest leverage on the rocker at the moment of opening against the terminal pressure. This arrangement occasions a minimum stress on push rods and side shaft. The inlet and the exhaust valves are interchangeable and housed in removable cages so that they are easily and quickly accessible without removing cylinder heads. At the forward end of the engine are placed a 6x6-inch air compressor, for furnishing starting and maneuvering air at 200 to 250 pounds pressure, and two water pumps, either one of which may be used for jacket circulation or for general service while the engine is running.

It was at first planned to use gasoline-engine-driven units for the auxiliary generating sets owing to the scarcity of suitable oil en-



The "Hustler" underway on the Delaware.

gines around 10 H.P., which was the size required. However, as this would have meant carrying two kinds of fuel; increased insurance rates; and added operating expense, it was finally decided to use about the only oil-engine set available which would run on the same fuel as the main engine. The two sets installed consist of 8-H.P., single-cylinder, Mianus oil engines, direct connected to 5-kilowatt, General Electric, 110-volt, direct-current generators. One set is of sufficient size to operate any of the auxiliaries under all ordinary conditions, and the two are arranged for parallel service if necessary in an emergency, when the fire pump at its full capacity may be needed. The Mianus engine uses the well-known Leissner system of fuel injection, and has 2-inch suction and discharge connections, and is good for 100-pound pressure in case of fire. For ordinary bilge, deck, and ballast work it requires only about 3 H.P., and the motor is therefore equipped with a Cutler-Hammer speed regulator which permits the pump to be operated at about half speed except when full capacity is needed. All three pumps are manifolded so that any one may be used for any purpose.

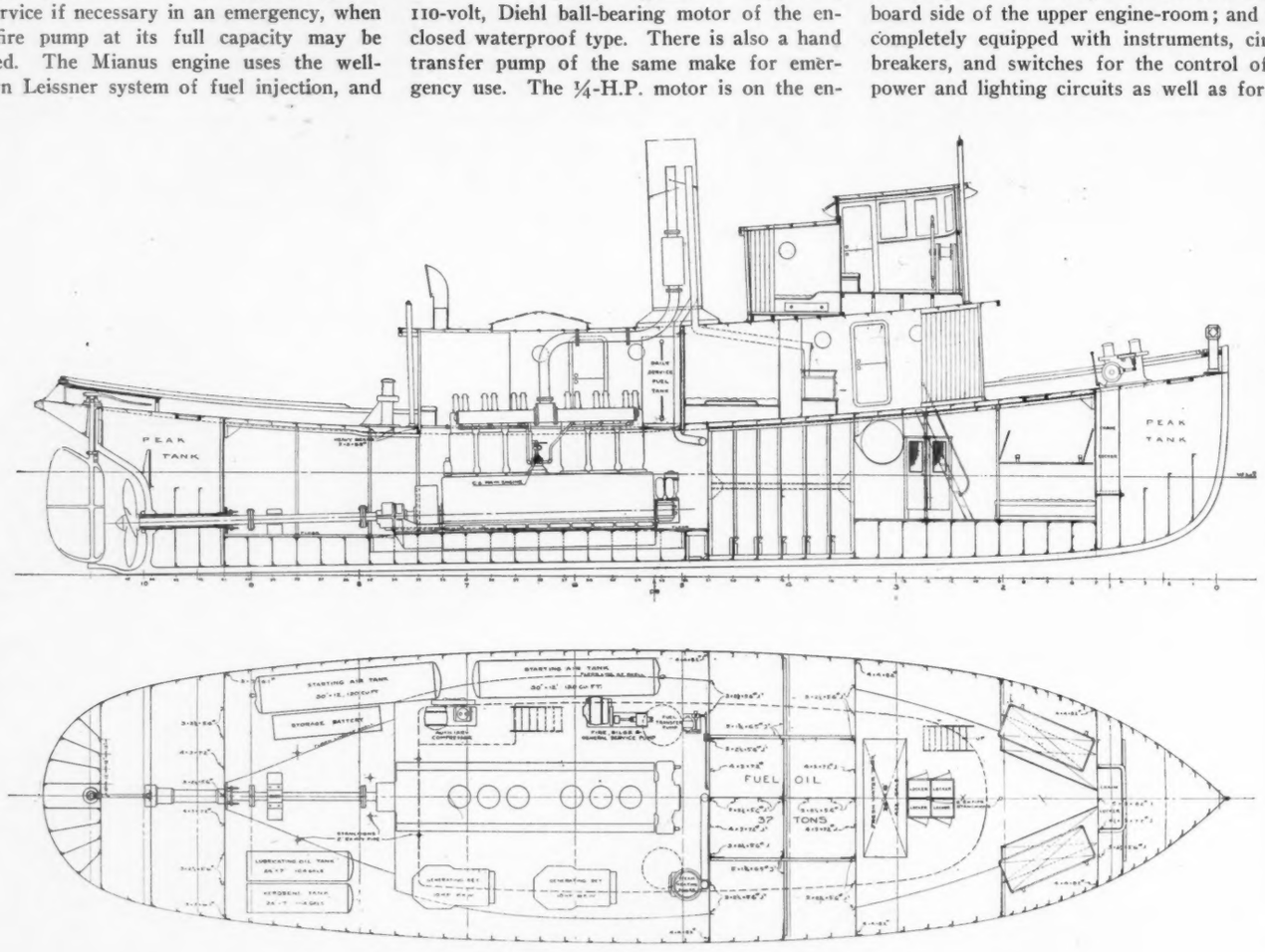
The fuel transfer pump is a 1-inch Blackmer rotary with a capacity of twenty gallons per minute. This pump is geared to a ¼-H.P., 110-volt, Diehl ball-bearing motor of the enclosed waterproof type. There is also a hand transfer pump of the same make for emergency use. The ¼-H.P. motor is on the engine-room lighting circuit so that this pump may be operated from the storage battery. The fuel is lifted from the main bunker to the two "day tanks" located above the grating at the forward corners of the engine-room. These tanks have a capacity of 266 gallons each, or a total of about 32-hours' supply for the two. The fuel is fed from the day tanks through an Andale duplex filter to the injection pumps on the main and the auxiliary engines.

The only power-operated deck machinery is an Alan Cunningham electric capstan placed alongside the after towing bitt and used for handling lines. It is of the combination hand-and-power type, with a back gear giving double power at half speed when reversed. The motor is of the 5-H.P., 110-volt, Diehl ball-bearing, semi-enclosed type, turning at 720 R.P.M. It is hung from the underside of the deck, and drives the capstan through a worm gear. The controller is of the Cutler-Hammer reversible-drum type with the operating handle projecting through the after end of the house to a convenient position alongside the capstan.

A 110-volt, 112½-ampere-hour, Edison storage battery furnishes current for lighting, and the battery is arranged for charging from either of the generating sets. A switchboard, furnished by the Smith Meeker Engineering Company of New York, is located on the starboard side of the upper engine-room; and it is completely equipped with instruments, circuit breakers, and switches for the control of all power and lighting circuits as well as for the charging and the discharging arrangements of the storage battery.

Steam heat for the pilot house and the captain's room, forecastle, and two staterooms is furnished by a small, low-pressure boiler, burning fuel oil, which is in the forward starboard corner of the lower engine-room.

Towboat owners have been a hard group to convince of the practicability of the oil engine for their work, although they are probably no more conservative in this respect than some owners of other types of vessels. However, they argue that the oil engine is not flexible enough for a tug; that its minimum revolutions are too high; and that it could not be backed or handled or started up slowly enough to compete with the steam engine even though its economy might be admitted. The



Inboard profile and hold plan of the towboat "Hustler."

shows a fuel consumption of around .5 pound per brake-horse-power-hour. This means a fuel cost of only about 2⅓ cents per hour as against 15 cents per hour—the outlay involved in running a gasoline set of the same size. The auxiliary air compressor is a 4½x5-inch Ingersoll-Rand machine, hopper cooled and connected by a short belt with idler pulley to a 7½-H.P., 110-volt, Diehl ball-bearing motor of the enclosed and ventilated marine type. The motor speed is 1,150 R.P.M., and that of the compressor 450 R.P.M.

The water pumping arrangements are exceptionally complete. In addition to the two 2-inch plunger pumps attached to the main engine, there is a 100-gallon-per-minute Blackmer rotary pump geared to a 10-H.P., 110-volt, Diehl ball-bearing motor. This pump

Hustler is an answer to those that may still cling to these unwarranted ideas; and they are at liberty at any time to watch her bring three barges up the Delaware River against the tide and dock them—each barge being over 200 feet long and loaded with 800 or 900 tons of sand. Her owners have been operators of steam tugs for many years, and they have stated that the *Hustler* pulls and backs and, in general, handles as well as any steam tug they have ever seen, and a lot better than some.

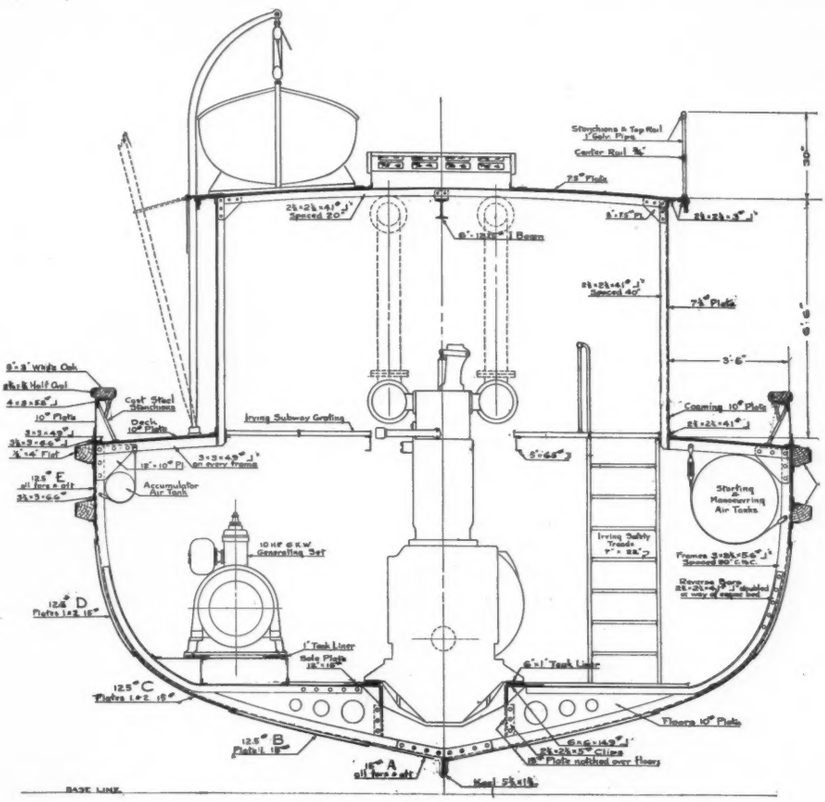
Due to the fact that she was badly needed, the tug was taken from the builder's yard before she was really finished, and was put into service without any trial trip or tuning up of the machinery. The first two trips, of about 300 miles up and down the length of Delaware Bay, were made without a representative of the engine builders on board and with a chief engineer who had had no previous experience with any type of oil engine—his only training in this line being a stay at the factory during the assembling and testing of the engine. These trips were completed with entire success; and only one or two minor troubles were encountered — these being due to lack of previous adjustment and tuning up. The boat has been in continuous service since the last week in August, averaging at least sixteen hours per day; and her performance has been so highly satisfactory that the owners have determined to eliminate steam tugs from their fleet as soon as possible.

The fuel consumption, loaded (towing two or three barges), is averaging fifteen to sixteen gallons per hour, and about ten gallons per hour light—the latter figure being due to the fact that the full power of the engine is not used when the *Hustler* is running at the rated number of revolutions per minute with the vessel light. The full-load fuel consumption works out approximately .4 pound per brake-horse-power-hour, which is .030 pound better than the engine-maker's guarantee. The fuel used is Mexican distillate, running 28 to 34 degrees Baumé, and costs around 4½ cents per gallon. One bunkering of 37 tons lasts about 40 days, assuming full-load consumption for 16 hours per day. This makes a maximum fuel cost of 72 cents per hour for the main engine. The fuel cost for the auxiliary engines is very small inasmuch as they are seldom used except for battery charging, which, possibly, takes a maximum of 16 horse-power-hours per day. At a rate of less than .50 pound per horse-power-hour, this would amount to only a little over a gallon, or an outlay of less than 6 cents per day.

The lubricating oil consumption for the main engine runs about 1 gallon for 4,000 horse-power-hours or 1.16 gallons per 16-hour day. This is a remarkably low figure, considering the very thorough manner in which the engine is lubricated, and is an important factor in the total operating cost.

No small part of the excellent performance of the *Hustler* is due to her propeller. Her screw was very carefully designed, in accordance with the Dyson method, by Mr. O. J. Peterson, and was cast by the American Manganese Bronze Company of Philadelphia—the metal being their "Hy-Ten-Sl" bronze, showing a tensile strength in this particular wheel of 92,000 pounds per square inch. The propeller seems to suit the vessel and her work exactly; and there is no indication that it could be improved upon in any respect: the horse-power, the speed, and the revolutions under the various towing conditions as well as in the light condition being in very close agreement with the performance as predicted by Mr. Peterson. The characteristics of the propeller are as follows:

Number of blades	4
Diameter	6 ft. 3 in.
Pitch	3 ft. 9 in.
Projected area	14.7 sq. ft.
Projected area ratio	.475
Developed area	15.9 sq. ft.
Developed area ratio	.519
Pitch ratio	.600
Brake-horse-power	300
Revolutions per minute	240



Cross section looking aft at Station 6.

The principal dimensions, etc., of the *Hustler* are:

Length, overall	82 ft. 6 in.
Length, load waterline	76 ft.
Breadth, load waterline	19.9 ft.
Depth, mean molded	9 ft.
Draft, mean molded	6.9 ft.
Displacement at 6.9-foot draft, in tons	159.6
Block coefficient	.538
Midsection coefficient	.798
Prismatic coefficient	.674
Tons per inch at Waterline No. 7	2.7
Moment to alter trim one inch	11.5 foot-tons

IMPROVED SLATE QUARRYING METHODS

WASTE slate is a problem of outstanding importance in the slate industry, for a very large proportion of all slate quarried is thrown on the waste heap. Dr. Oliver Bowles, mineral technologist of the Bureau of Mines, informs us that while many uses for waste slate have been found, still the demand calls for merely a fraction of the present supply of unused material. If the slate industry is to increase in prosperity, the producer's energy must be directed toward the development of ways and means to reduce this waste to the lowest possible point.

A process of drilling and broaching, as a substitute for channeling or blasting, is now being tried out in certain Pennsylvania slate quarries in an effort to reduce the waste due to shattering. The cutting rate is about half as fast by the new method as by the old one, but the rock is so little damaged that the proportion of usable slate is greatly increased. Moreover, the investment cost and the expense of maintenance are lower for drilling than for channeling. The new mode of operation has scarcely passed the experimental stage, but it seems likely that the new method will become more and more successful as improvements are brought about as a result of experience.

Willie Mitchell, of Augusta, Ga., has a farm of a few square yards devoted to the propagation of angle worms for fishermen, and he has already realized so much money on it that we dare not reprint the figures given in the *Manufacturers Record*. He is raising worms by wholesale—very wholesale—and is shipping them all around the country, even up into the eastern cities. He always keeps on hand ten gallons of worms ready for any emergency; and he estimates that there are 4,100 worms in a gallon.

Progress on the Big Creek Hydro-Electric Project

The Southern California Edison Company, Through This Vast Developmental Work, is Converting the Force of Nature's Falling Waters into Electrical Energy

PART I

By D. H. REDINGER*

THE PAST ten years, and more especially the past five years, have seen an enormous growth in California, not alone in population but, likewise, in manufacturing, in agriculture—in fact, in many lines of industrial activity. This remarkable expansion has been particularly pronounced in the southern half of the state—the territory in which the Southern California Edison Company, in 1922, furnished a total of 902,000,000 kilowatt-hours of electric energy to a connected load aggregating nearly 800,000 H.P. It has been the aim of this company to keep step with the developments in its territory, and it has obligated itself to supply the rapidly increasing demand for power with electric energy at lowest practicable rates.

For this reason, the company has looked toward the snow-covered peaks of the Sierra Nevada mountains east of Fresno, with their rugged slopes and rushing streams, as the natural source of this power. It is there—on the upper reaches of the San Joaquin River and its tributaries—that the company has at the present time developed 137,000 H.P. of continuous hydro-electric energy for the needs of the extensive cultivated fields and the centers of population in the valleys below; and it is there that it will continue to develop power for the next ten or twelve years, or until a total of over 1,400,000 H.P. is being distributed throughout the southern half of the state. With nearly 5,000 men on the job, all efforts are being bent toward the rapid completion of additional installations, which will increase the output by 122,000 H. P.—thus contributing to the system, at the end of the current year, a total of 259,000 H.P. from the Big Creek plants.

FOR thousands of years the snows of the high Sierras melted annually and formed rushing torrents that spent themselves quickly—leaving many deeply graven watercourses dry or little more than puny streams throughout the succeeding months.

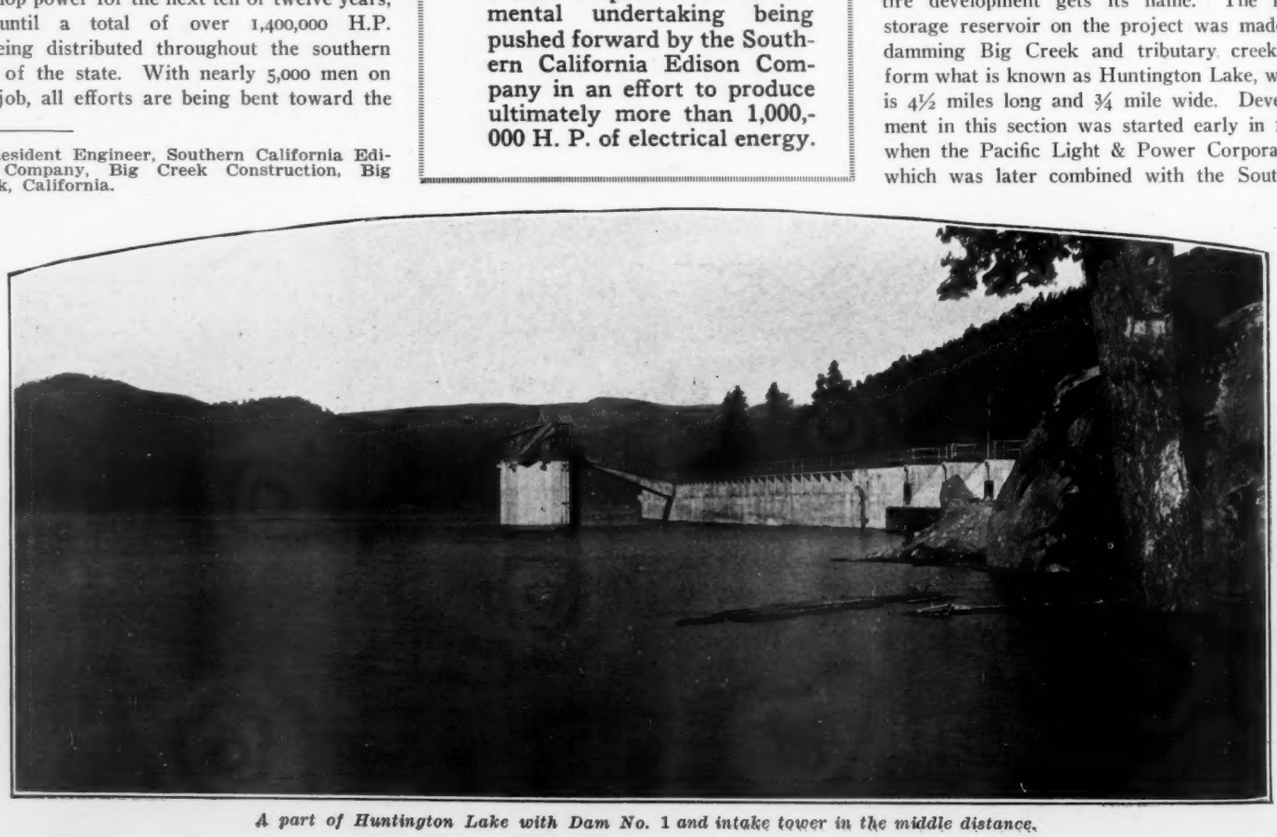
Now, the engineer, by erecting impounding dams, by driving tunnels, and by constructing large and long steel arches, is arresting the superabundance of springtime floods so that the wintry mantle of the mountain tops can be transformed into power capable of being evenly distributed, day in and day out, from the beginning to the end of each year.

This work of conservation, this use of water's latent force, is one of the wonders of the West; and our story gives an outline of part of the monumental undertaking being pushed forward by the Southern California Edison Company in an effort to produce ultimately more than 1,000,000 H. P. of electrical energy.

Together with the three plants now in operation and those in course of construction, the development will cover territory, in Fresno and Madera Counties, 760 square miles in extent, and will utilize all the water in this section through twenty or more power houses located so as to take advantage of practically every foot of fall between the 7,000 and the 1,000-foot elevations. A comprehensive system of storage basins will provide a uniform flow through these plants—the water being delivered back into the San Joaquin River at a fairly constant rate throughout the year. This feature will prove of inestimable benefit to the great agricultural areas of the San Joaquin Valley in that it will insure a maximum flow for irrigation purposes at times in the year when the flow would otherwise be at a minimum.

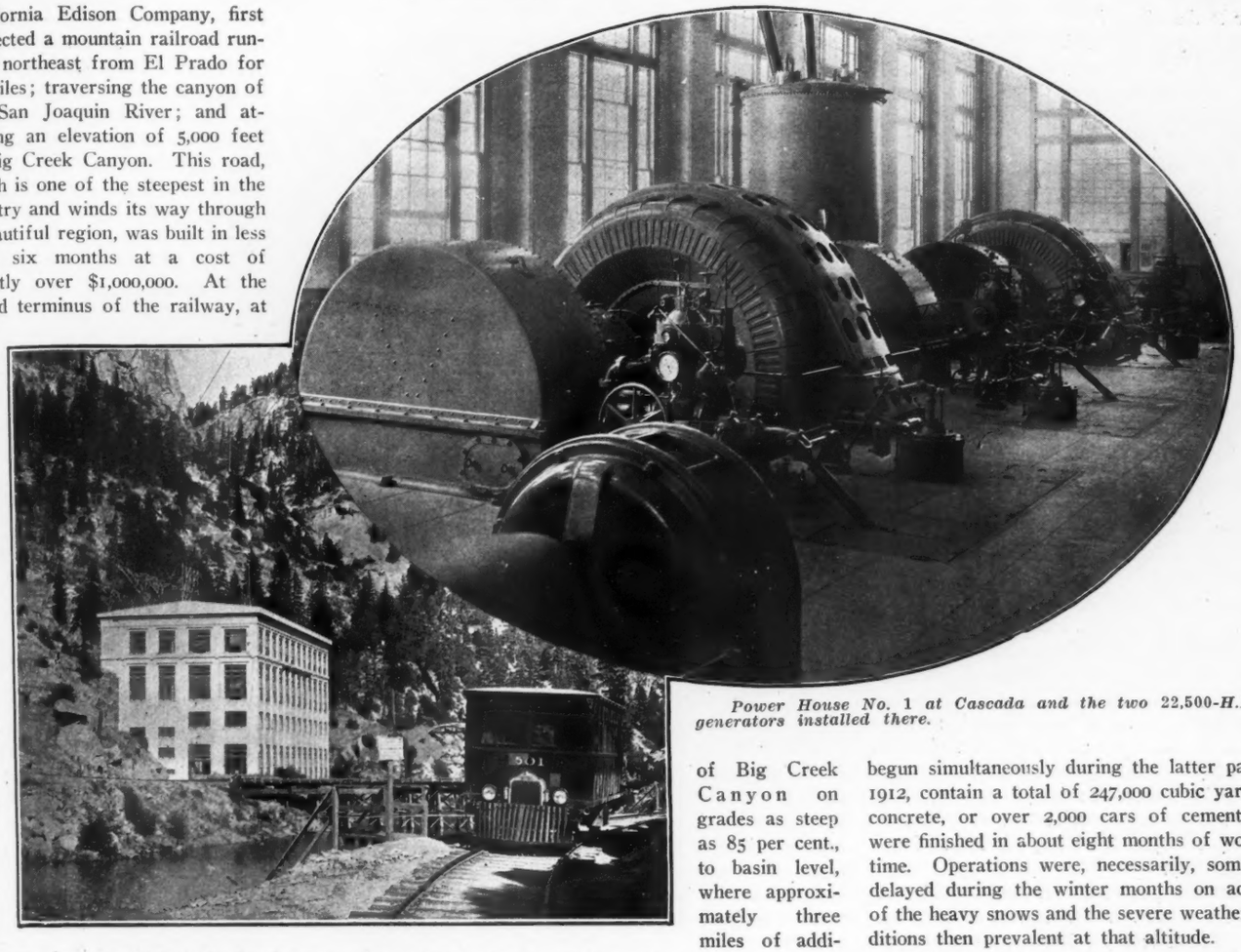
One of the principal tributaries of the San Joaquin River is Big Creek, along the steep slopes of which three power houses are now in operation. It is from this source that the entire development gets its name. The main storage reservoir on the project was made by damming Big Creek and tributary creeks to form what is known as Huntington Lake, which is 4½ miles long and ¾ mile wide. Development in this section was started early in 1912, when the Pacific Light & Power Corporation, which was later combined with the Southern

*Resident Engineer, Southern California Edison Company, Big Creek Construction, Big Creek, California.



A part of Huntington Lake with Dam No. 1 and intake tower in the middle distance.

California Edison Company, first projected a mountain railroad running northeast from El Prado for 55 miles; traversing the canyon of the San Joaquin River; and attaining an elevation of 5,000 feet in Big Creek Canyon. This road, which is one of the steepest in the country and winds its way through a beautiful region, was built in less than six months at a cost of slightly over $1,000,000. At the upped terminus of the railway, at Cascada, was established the headquarters for the development.



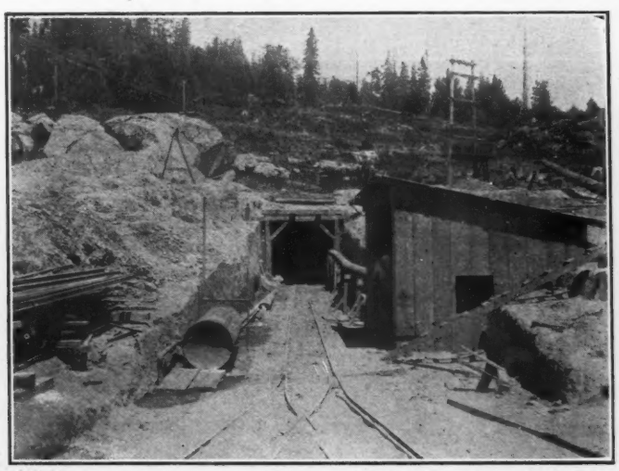
Power House No. 1 at Cascada and the two 22,500-H.P. generators installed there.

Two thousand feet above Cascada, and less than two miles to the northeast, was a natural basin which provided an almost ideal reservoir site with a drainage area to the north and east of 79 square miles. To reach this site by rail, in order to bring in the great quantities of materials necessary for the erection of three large dams, a standard-gage, cable-operated incline was built from rail head, up the north wall of Big Creek Canyon on grades as steep as 85 per cent., to basin level, where approximately three miles of additional track reached the dam sites.

While the railroad and the incline were being completed, plans were under way and camps were being established preparatory to erecting three gravity-type concrete dams across the canyons of Big Creek and two of its tributaries, which would hold the water at Elevation 6,915 and form a storage basin of 55,000-acre-feet capacity for the purpose of supplying the power houses below with a continuous flow of water throughout the year. The three dams, begun simultaneously during the latter part of 1912, contain a total of 247,000 cubic yards of concrete, or over 2,000 cars of cement, and were finished in about eight months of working time. Operations were, necessarily, somewhat delayed during the winter months on account of the heavy snows and the severe weather conditions then prevalent at that altitude.

While the work on the reservoir was in progress, construction was well along on the first power house, located 2,100 feet below at Cascada, and known as Power House No. 1. To carry the water from Huntington Lake to Power House No. 1 required digging a circular tunnel, 4,000 feet long and 12 feet in diameter, through solid granite, the lower end to connect with a steel pipe line 6,000 feet long and 84 inches in diameter. This 10,000 feet of flow line, on a grade of 2 feet in 1,000, conducts the

Dump at the intake portal of Shaver Tunnel. This tunnel is 14,300 feet long and is 8x11 feet in cross section.



Intake portal of Shaver Tunnel which has been driven to tap a man-made lake.

water to the edge of Big Creek Canyon, where it is diverted into two heavy steel penstock pipe lines and carried thence down the steep canyon slope. The penstocks, each of which is 4,350 feet long, taper from 44 inches in diameter at the top to 24 inches at the bottom; and the steel of which they are made ranges in thickness from ⅜ inch to 1⅛ inches at the power-house wall.

Shaver Lake showing the crest of the 40-foot rock-fill dam at extreme right.

Power House No. 1 was designed for the installation of two 22,500-H.P. generators, each impelled by two 9-foot-diameter Pelton wheels on a horizontal shaft. The generators deliver power at 6,600 volts to banks of transformers which step it up to 150,000 volts; and at this voltage the current is carried over a double circuit transmission line, composed of six 1-inch aluminum cables, to the distributing centers, some of which are quite 240 miles away. By November 1913, the dams had been erected to form Huntington Lake; the 4,000 feet of tunnel dug; the 6,000-foot pipe line and the 8,700 feet of penstock laid; the power house built and the machinery installed, and the wheels were then turned over for the first time to supply the system with 45,000 H.P. of additional energy.

Less than four months after the completion of Power House No. 1, a virtual duplicate of it had been built and put into operation four miles further down on Big Creek Canyon and 1,860 feet lower in elevation. This power house, known as No. 2, picks the water up at the tailrace level of Power House No. 1 by means of a small concrete arch diversion dam across Big Creek, where the water passes through a 12-foot-diameter tunnel, 21,600 feet long, that parallels Big Creek Canyon and is built on a slope of 3.2 feet in 1,000. This tunnel delivers the water to a forebay excavated in solid rock on the canyon slope. From there the flow is carried down the hillside to Power House No. 2, at the bottom of the canyon, in two penstock pipes which are similar to those for Power House No. 1. A standard-gage, cable-operated incline, paralleling the penstocks, connects the railroad at the forebay with the power house. Two generators, of the same design and capacity as those in Power House No. 1, deliver 45,000 H.P. to the transmission line—making a total of 90,000 H.P. supplied by these first two plants.

Between the time of completion of these power houses in 1914 and the summer of 1917, the company's power requirements were taken care of by these two plants, supplemented by smaller hydro-electric stations in the southern part of the state and two large steam plants, all belonging to the system. However, it was soon found that the steadily increasing power demand would call for additional plant capacity, which, in turn, would necessitate additional storage capacity. After obtaining more accurate water records of the annual inflow into Huntington Lake, it was decided to augment that reservoir's size by raising the dams.

During the summer of 1917, the three dams were heightened 35 feet, bringing them up to Elevation 6,950, thereby swelling the reservoir capacity from 55,000 to 88,000 acre-feet. With this amplified flow of water, capable of supplying additional generators, the next step was to install in Power House No. 2 a third unit of the same design and capacity as the original two. This required the laying of another penstock pipe from the forebay down to the power house. The work was started in the early summer of 1920; and the generator put on the line in November of that year raised the total ouput of Power House No. 2 to 66,000 H.P.

Another feature of the project, begun in 1920, was the driving of an 8x11-foot tunnel, 14,300 feet long, to tap Shaver Lake. Shaver Lake is an artificial body of water; and was created some 30 years ago by the Shaver Flume & Lumber Company for use in their lumber operations. It is approximately two miles long, and was formed by means of a rock-fill dam, about 40 feet high, built across Stevenson Creek—a tributary of the San Joaquin River that enters the latter stream something like three miles below the mouth of Big Creek. This lake, which is located 4½ miles due south of Power House No. 2, lies at an elevation of 5,275 feet, or 2,400

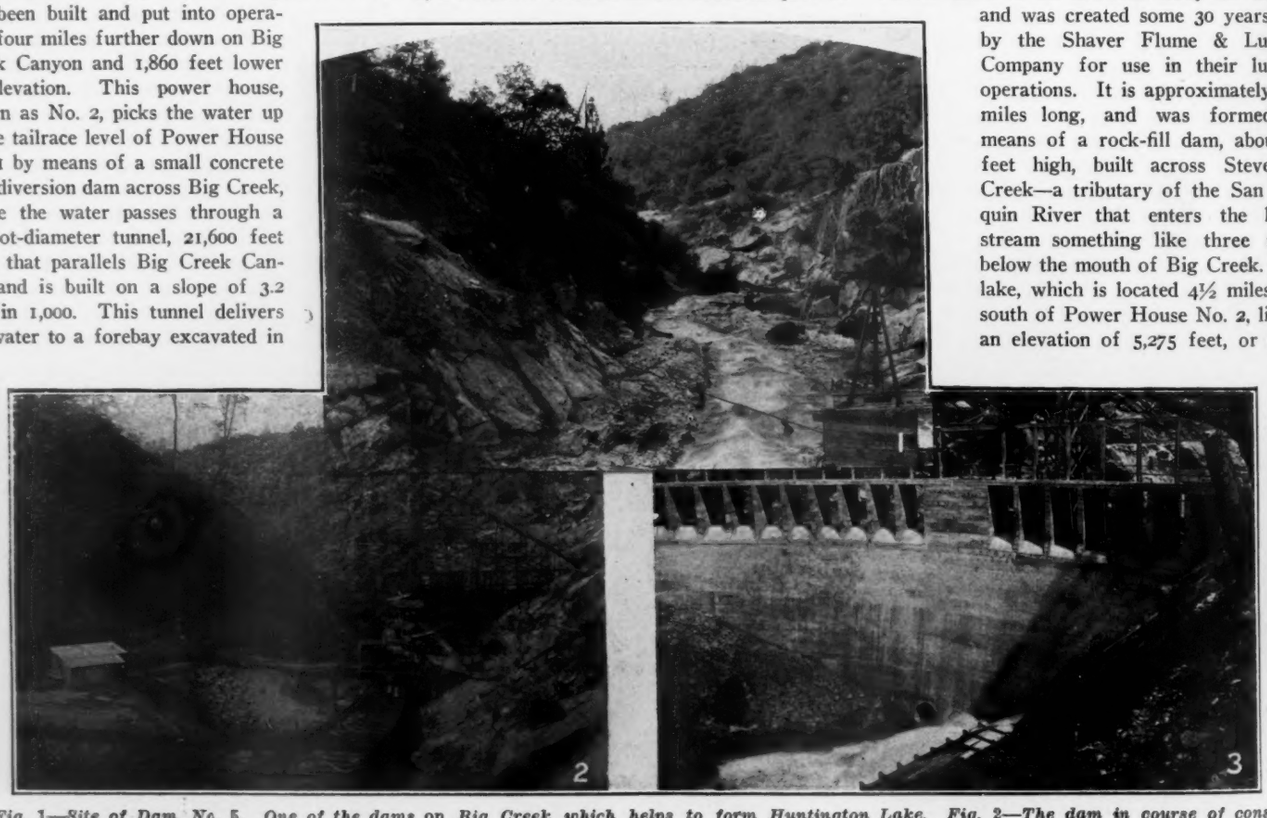


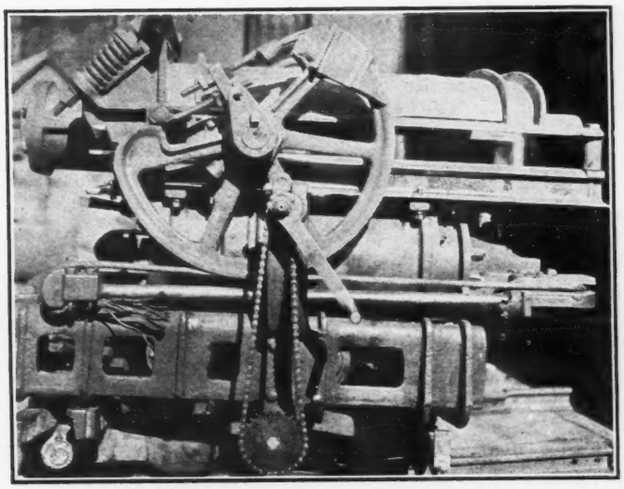
Fig. 1—Site of Dam. No. 5. One of the dams on Big Creek which helps to form Huntington Lake. Fig. 2—The dam in course of construction. Fig. 3—Dam 5 when finished.

VARIOUS ASPECTS OF WORK ON POWER HOUSE NO. 2 AND SHAVER LAKE TUNNEL

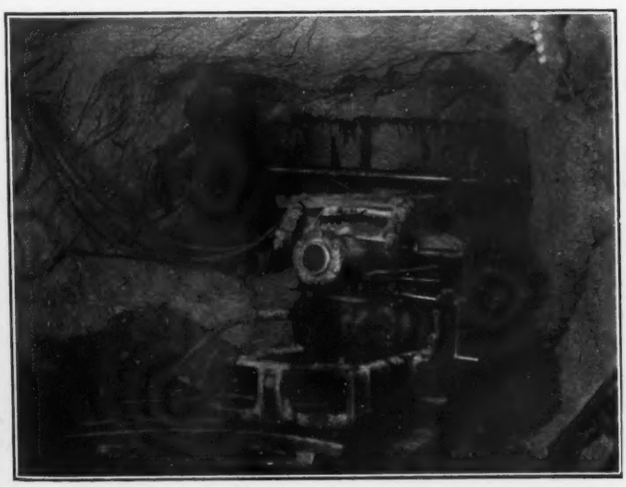
Third unit in Power House No. 2, a 22,500-H.P. generator.

A transformer for Power House No. 2 at crest of steep incline.

Transporting penstock pipe under difficulties for Power House No. 2.



Type of air-operated mucking machine used in driving Shaver Tunnel.



One of the pneumatic mucking machines in action in Shaver Tunnel.

Storage battery locomotives of this sort did the hauling in Shaver Tunnel.

feet above the power house, and has a drainage area of 30 square miles and a storage capacity of 5,200 acre-feet. By diverting the outflow of this lake from its natural westerly course, which carried it into the San Joaquin River, and by directing it north through a tunnel under Musick Mountain into Big Creek Canyon, this water would become available for use in Power House No. 2, under a head of 2,400 feet, and for all power houses below it.

Work was started on Shaver Tunnel on February 5, 1920, and the undertaking was completed on May 6, 1921. One adit, 400 feet long, near the middle of the tunnel permitted excavation to be carried on simultaneously at four headings. The rock encountered was hard granite, with very little seamy material, so that less than 1,000 feet of the entire length of the tunnel required timbering. Drilling was done with No. 248 "Leyner" pneumatic drills, driving from 28 to 34 six-foot holes per round; and three complete rounds were drilled, blasted, and excavated every 24 hours—a shift working at each heading all the time. The blasted material was mucked with air-operated "shuveloders" working under the same pressure as the drills, that is, at about 100 pounds per square inch, and these placed the broken rock into 1-yard Koppel dump cars. The latter were hauled to the portal by storage-battery locomotives. A total of 550,000 pounds of 40 per cent. and 60 per cent. blasting gelatine was used in driving the tunnel.

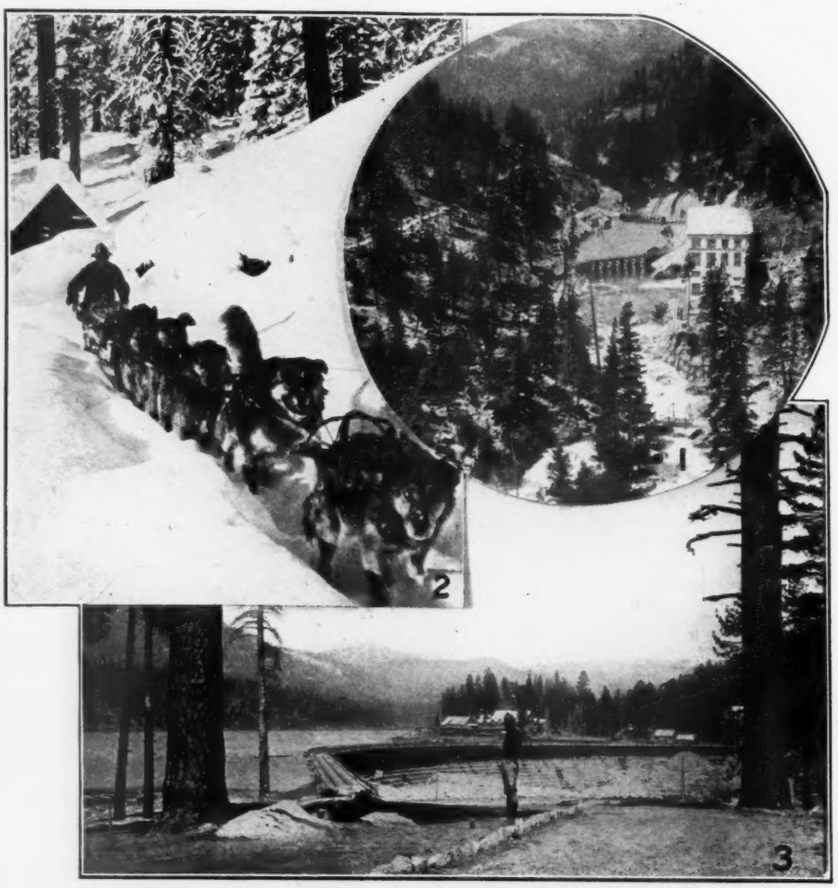


Fig. 1— Power House No. 1 on Big Creek at an altitude of 5,000 feet. The water which turns the turbines comes from Huntington Lake, 2,100 feet above. Fig. 2—A winter scene in the Sierras giving some idea of the difficulties involved in getting supplies of various sorts to the construction camps. Fig. 3—Part of Huntington Lake, which lies 7,000 feet above the sea. The lake is 4½ miles long and ¾ mile wide.

The excellent progress made on this part of the undertaking can be primarily attributed to the use of modern tunnel equipment, such as "shuveloders," "Leyner" drills, and pneumatic drill-sharpening machines, which were furnished operating air at each heading by two 700-foot compressors; to the employment of electric locomotives; and to the installation of blowers which kept the air fresh at the working faces. All these facilities served to reduce labor to a minimum and helped to keep the men contented. An average crew of 90 men worked continuously throughout the job at each of the four headings; and at one heading a maximum advance of 522 feet was achieved in the course of 30 days.

Because the present outflow from Shaver Lake did not justify the adoption of higher head machines in Power House No. 2 and, therefore, a correspondingly longer penstock line, water from Shaver Lake is carried through a temporary diversion tunnel and pipe line into Tunnel No. 2, just above the forebay, and this water is used in conjunction with water from Big Creek in Power House No. 2 under a head of 1,860 feet. However, as we shall describe in a later installment of this article, the capacity of Shaver Lake will ultimately be increased several fold, and the inflow augmented accordingly. To bring this about, a forebay will be constructed at the Shaver Tunnel outlet, and advantage will be taken of this additional 400 feet of head by erecting another station which will be known as Power House No. 2A, to be located adjacent to Power House No. 2.

(To be continued.)

The go-as-you-please railroad ticket certainly appeals to us. In pre-war days certain of the smaller railways in England used to issue tickets of this sort, which enabled the holders to go back and forth as they pleased within prescribed limits of time and location. Such tickets are again being issued by the Southern Railway for stations on the Isle of Wight; and the scheme would seem to be quite practicable and well worth trying in other localities.

The American population in China has grown from about 3,000 in 1903 to 12,000 at the present time.

CONCRETE RAILWAY TIES

THE North Western Railway of India has made exhaustive tests of a new type of concrete railway tie patented by a Delhi consulting engineer. Experiments have been made on 50 miles of main-line track near Delhi, and the results have been so satisfactory that 70 additional miles will be similarly equipped as soon as the necessary ties are manufactured. The tie consists of two concrete blocks joined together by a tie bar—the rails being fastened by means of a screw or dog spike driven into wood plugs, specially treated and compressed, set in the bed of the concrete block.

The other Indian railways are, likewise, interested in concrete ties. The East Indian Railway has been using a large number of Green-Moore reinforced - concrete ties for seven years, and has now nearly completed a factory for manufacturing 500,000 per annum. The Green-Moore tie is the invention of the deputy chief engineer of the East Indian Railway, and is similar in construction to the type in use on the North-Western Railway. They have been favorably reported on by the Senior Government Inspector of Railways, who states that they are still in perfect condition after about eight years of service and show no signs of weakness. The Bengal Nagpur Railway has decided to adopt the Green-Moore tie, and has acquired a license to manufacture 300,000.

WATER-RESISTING GLUE

THE United States Forest Products Laboratory at Madison, Wis., has improved and perfected a casein-silicate glue used during the war. The improvement consists in the addition of certain copper salts to the old formula—giving the glue more strength and water-resisting properties.

The formula was given to a number of woodworking factories which made use of it until they were stopped by threats of suit for infringement by an applicant for a private patent to cover the same formula discovered by the government chemists. Upon consideration of the evidence as to priority, the Patent Office granted the patent to the Forest Products Laboratory to be dedicated to the people of the United States for their free use.

Fine Work Done in Restoring a Great Trainshed Damaged by Fire

By RICHARD HOADLEY TINGLEY

ON OCTOBER 10, 1892, the *Philadelphia Morning Times* published a long description of the Pennsylvania Railroad's Broad Street Station, then just completed in that city—the headlines of the article reading:—

PENNSY'S NEW HOME
PLANS FOR THE LARGEST AND HANDSOMEST STATION IN THE WORLD
A MODEL IN EVERY DETAIL
EVERY POSSIBLE CONVENIENCE FOR THE TRAVELING PUBLIC
THE MAMMOTH TRAINSHED

This was just 31 years ago, and the "Pennsy's" station still stands, doing business as effectively as ever—the disastrous fire of last June did little or no damage to the station proper. It did, however, do great damage to the trainshed, its floor, tracks, platforms, walls, and roof. In other words, the trainshed was reduced to ruins, as the photographs clearly show. Notwithstanding this, and because the company was prepared to meet just such an emergency, passengers were incommoded but a short time; and within a few days traffic flowed in and out of the station just as if nothing had happened.

Through the courtesy of the Pennsylvania Railroad we are able to tell something about the extent of the damage done; the prompt methods adopted for relief; the intensive and rapid work of reconstruction; and the changes in the old order of things made necessary or advisable as a result of the fire.

Broad Street Station is the center of the heaviest passenger traffic on the Pennsylvania Railroad System. It is said to be one of the three or four busiest passenger stations in the United States, and it ranks among the most important in the world. It accommodates each day 530 incoming and outgoing trains, requiring 2,217 distinct train and engine movements over its tracks. More than 80,000 passengers are brought in and carried out of the station daily, including a large portion of the city's commuting population.

IT IS popularly said that the Pennsylvania Railroad is so forehanded that it has plans prepared to meet almost any emergency likely to occur on its lines.

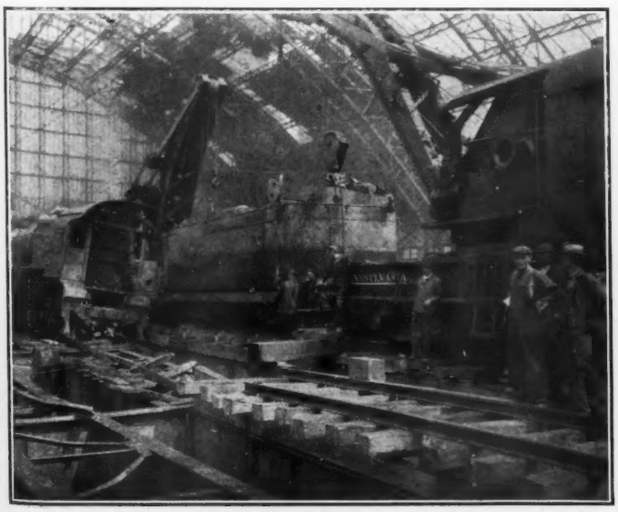
If, for instance, Bridge No. 786 fails; if floods destroy tracks along the Susquehanna or other river; if lightning strikes one of its big power houses and puts it out of business, there are detailed plans on file to meet the situation so that its engineers, superintendents, and managers know just what to do.

It so happened, therefore, that when the Broad Street trainshed at Philadelphia caught fire, the proper officials of the company were prepared to cope with the problem.

That is why reconstruction has been so rapid—why passengers have been subjected to the least possible inconvenience on account of the fire that occurred last June. In this article the author tells how this record work was accomplished.

The threatened stoppage of this heavy traffic represented an emergency of the first magnitude. The fire started about 1 A. M. on June 11, last; but, long before it had gained full headway, arrangements had been perfected to take care, at the West and the North Philadelphia stations, of the early tide of incoming people and to dispatch outgoing trains from the West Philadelphia produce freight yard. The railroad reports that 100 per cent. of the inbound trains and 95 per cent. of those outgoing were handled the first day, and that 100 per cent. service was reached the next day in handling traffic in both directions. Before daylight, and while the fire was at its height, the building of temporary facilities was begun to bring commuters to their destination in the heart of the city. These consisted of platforms, with wooden stairways leading to the street from both sides of the elevated tracks, and were located a block beyond the outer end of the trainshed—near to but out of reach of the flames which were still raging.

In the meanwhile, as the mass of wreckage cooled, the rebuilding of the platforms and tracks beneath the warped and twisted steel skeleton of the arched roof was begun. Forty-eight hours after the fire had started, the first reconstructed platform was complete from the outer edge of the trainshed to the lobby or concourse gates. This permitted the partial resumption of passenger movement by the old channels. On that day, mark you, two days after the conflagration, the full suburban elec-



Removal of rolling stock, caught in the station by the fire, was one of the heavy problems that had to be disposed of with dispatch.

How the station looked while the fire still burned but when the flames were under control.

How the station looked during the very earliest stages of reconstruction.

tric service of 151 trains could be taken care of at the temporary platforms just beyond the outer end of the trainshed.

On June 14, two tracks were restored to service, complete with platforms all the way to the concourse gates, and four days later, on June 18 to be specific, the sixteen tracks had been fully repaired, and 70 per cent. of the trains were back in their old places. The needful employment of much machinery, many derricks, etc., which blocked up some of the available track space while removing debris, accounts for the fact that 30 per cent. of the train movements had to be transferred to West Philadelphia.

Repair work was carried on so rapidly that inside of seven days sixteen tracks were in service.

The photographs reproduced here, some of which were supplied through the courtesy of the railroad, give a good idea of the work of reconstruction in which, it is officially stated, was used 2,000,000 feet of lumber; 100,000 pounds of nails; 200 tons of rails; 150,000 feet of electric wiring temporarily swung from all manner of points of vantage; 15,000 feet of cable; 350,000 feet of telegraph wire; and 300 tons of pipe and fittings.

The fire so completely damaged the floor and its supporting girders that they presented a discouraging spectacle. Locomotives and cars were trapped in the trainshed; and tracks were demolished to such an extent that the equipment had to be removed by derricks. The mailing room and other allied departments were located under the warped girders, and these, too, suffered greatly.

The beauty of the Broad Street Station lay in the graceful, arching roof of steel that spanned the entire trainshed with its sixteen tracks. This is now a thing of the past. Damaged and twisted as it was, and thereby rendered unsafe, it had to be removed, and is being replaced by the more modern type of so-called "umbrella" shed—that is, a separate cover for each platform.

The work of removing this immense tangled mass of steel was one of the last operations of reconstruction. In order to insure the safety of the thousands of passengers constantly passing to and fro, a temporary, portable, wooden arch was first built to fit beneath the steel arch to catch any falling material. This structure was mounted on trucks running on the outermost tracks parallel with the trainshed; and was shifted from point to point as the busy workmen overhead changed their positions. Armed with acetylene torches the men aloft readily dismembered the steelwork; and, as soon as one section was dissociated from the rest of the structure, a huge derrick gripped it and carried it to a flatcar near by for subsequent haulage to the junk pile. In this manner, piece by piece, the broad arch has disappeared.

The removal of the arch and of its side supports would have left the trainshed end of the lobby, or concourse roof, without means of support. New girders, resting on new columns, were therefore necessary; and this work had to be done in the very busiest part of the entire station where every inch of room counts during rush hours. A derrick was, of course, necessary, and to operate a derrick one usually needs a boiler to furnish the steam. But a

Here we see all the platforms finished and the supporting columns for the umbrella sheds in place.

The pneumatic drill proved very helpful in clearing away old steelwork.

boiler in that congested spot was out of the question. Yankee ingenuity came to the rescue; and passengers hurrying in and out no doubt wondered how the boilerless derrick was worked. If they had looked carefully, however, they would have discovered a line of rubber hose, terminating at the derrick, coming up from somewhere underneath. In other words, the derrick was operated by means of compressed air.

Compressed air came to the aid of the wreckers and reconstructors in numerous ways. The side walls of the old trainshed had to be torn down, and pneumatic tools were employed to attack the masonry of 31 years' standing.

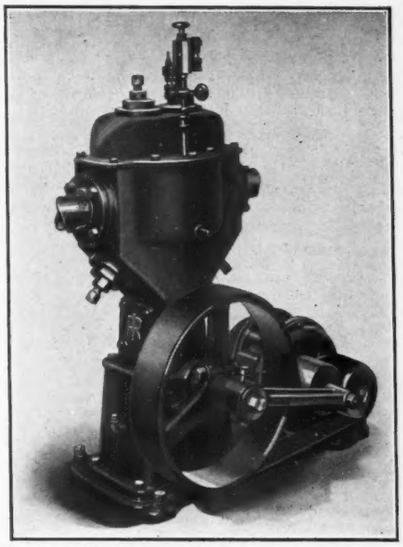
On the parapet of these walls there were stone engravings in bas-relief, each picturing some episode in the founding of the various principal cities through which the Pennsylvania Railroad System passes and showing the coat of arms of the city represented. All are works of art—too valuable to be demolished. Special care was exercised in removing these and in placing them in safety—a delicate stone-cutting operation successfully accomplished by means of pneumatic tools in the hands of trained workmen. Without the aid of these tools the cost of the undertaking would have been excessive and the figures would probably have gone onto the scrap heap along with the rest of the wall. The Pennsylvania Railroad has offered these bas-reliefs as souvenirs to the various cities with which they are associated. Some have already accepted them; and, with the exception of two or three which suffered damage from the fire, it is expected that the sculptures will all be disposed of in this manner.

The compressed air plant which so greatly assisted in the work of demolition and of rebuilding the Pennsylvania station, even though directly under the trainshed, suffered but little from the fire. It consists of a battery of 28x20, 25x20, 18x20, and 15x20-inch, Type XC-3 machines, and of 12 and 18½ and 12¼x12-inch Type X-2 machines, which have for years supplied all the compressed air used in the terminal yard.

NEW LINE OF SMALL VACUUM PUMPS

OF PARTICULAR interest to users of high-grade, standard, reciprocating, dry vacuum pumps of small capacities is the announcement, by the Ingersoll-Rand Company, of a new line of small, vertical vacuum pumps known as Type Fifteen. These vacuum pumps are available in six sizes, ranging in capacity from 10 cubic feet to 250 cubic feet per minute piston displacement.

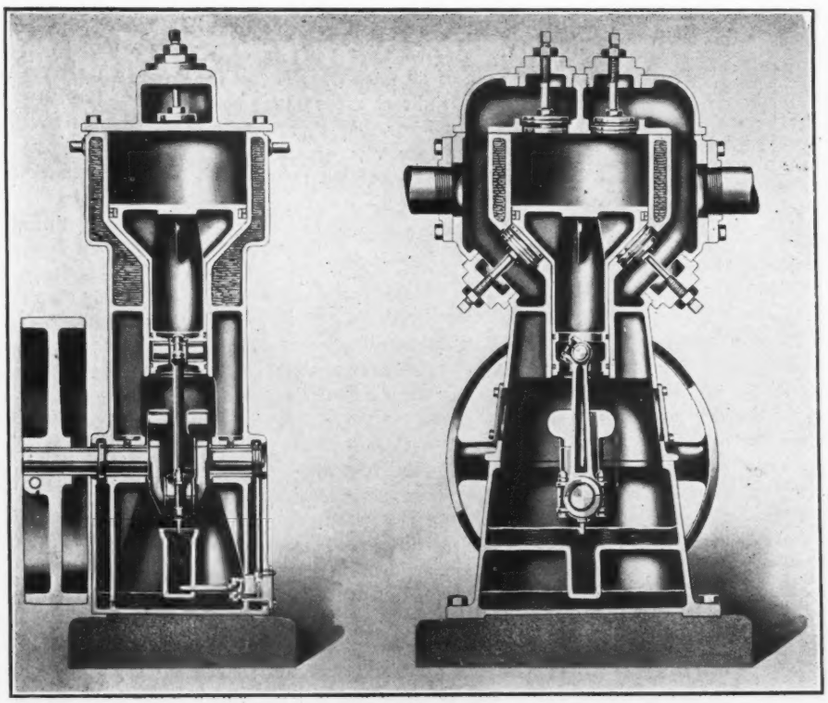
The wide range of capacities and the different methods of drive of these pumps make them especially adaptable to the needs of any plant where a high vacuum is necessary. It is claimed for these vacuum pumps that they will pull and maintain vacuums between 28.6 and 29.25 inches, depending on their size. In addition to the standard belt-driven design, each size is built as a self-contained electric motor outfit which can be turned over either by a short belt arrangement or by a pinion and internal gear. The vacuum pump and the electric motor in both the short-belt and the gear-driven units are mounted on a metal sub-base, so that they are not dependent on the foundation for correct alignment.



New 12x6-inch Type Fifteen vacuum pump.

The system of lubrication used maintains a constant level of oil in the pan into which the connecting rod dips, and insures the distribution of just enough oil for the proper lubrication of all parts. It is said that this "Constant-Level" system prevents the consumption of either too much oil or the delivery of too little oil for proper lubrication. These shortcomings are rather common in other systems; and we all know that an insufficiency of oil will lead to scored cylinders, burned-out bearings, and overloads.

A bulletin describing and illustrating these vacuum pumps can be had on application to the manufacturer.



Vertical cross sections of Type Fifteen vacuum pump.

ELECTRICAL IMMUNITY

GREAT differences exist in the capacity possessed by different people to resist electrical currents; and as this endurance capacity can be proved only by experiments few will be willing to undergo the test.

Lord Kelvin is said to have been practically immune to current that would have sufficed to electrocute any ordinary man; and this was of advantage to him in connection with his numerous electrical experiments. He considered that his immunity was due to the exceptional dryness of his skin.

On the occasion of the opening of a certain railway, Kelvin startled his friends by gripping a copper conductor with his bare hands when it was carrying a current of 500 volts. He probably knew quite well when to do it, and when not to do it.

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EDITORIALS

OUR FAVORABLE POSITION IN FOREIGN TRADE

WE HAVE it on the authority of the United States Department of Commerce that the foreign trade of this country was never before in such an encouraging condition.

This should be heartening news to every branch of domestic industry because, sooner or later, the national welfare hinges to a considerable extent upon the profitable exporting of our surplus commodities—the surplus which represents the operation of our plants at their economical best, that is, at capacity.

According to the Government experts, the last fiscal year, which ended on June 30, was a period of notable alterations in trade movements which helped to put the business of exporting and importing on a sound basis. Imports increased and at the same time more closely approached the volume of exports, and by so doing a top-heavy export balance was avoided. It was this top-heavy export balance which upset our trade relations during a number of the years following the armistice.

Another favorable development has been the gradual slowing up in the volume of our gold imports. We are assured by the students in Washington that there is little likelihood of a renewal of a heavier inflow of gold. As they point out: "Our gold surplus will eventually flow outward," but, as they express it, "there are advantages to Europeans in keeping their gold balances in the United States."

We cannot here enter into a detailed analysis of the situation as disclosed by the departmental report, but we can sum up with one of the findings, to wit: "The stronger position of our foreign trade—stronger than that of most other countries, is shown by the fact that trade with the United States is a more important factor in the foreign trade of nearly every leading commercial country than it was prior to the war; and the value of our exports exceeds that of any other country while our imports are second only to those of the United Kingdom."

NATIONAL RAILROADS SHOW MARKED IMPROVEMENT

AT THE RECENT meeting of nationwide railroad organizations it was disclosed that the American lines had actually spent or obligated for expenditure during 1923 the amazing total of more than $3,000,000,000 on maintenance. This was a revelation of record-breaking disbursements.

At that conference, statistics were made public that revealed just how the railroads were doing their utmost to make themselves equal to the unprecedentedly heavy task of transportation laid upon them by our manifold industrial life. It seems that the capital outlays for equipment and permanent improvements will aggregate before the year is done a matter of $1,059,440,000. In addition, there will be carried over into 1924 appropriations made this year for kindred capital expenditures amounting to $243,804,000. This does not include appropriations which will be covered in the 1924 budgets.

Supplementing the foregoing sums for amplifying their facilities, Class 1 railroads will show an expenditure during 1923 of substantially $1,800,000,000 for fuel, material, and supplies. In other words, the combined disbursements or obligations for increased facilities, fuel, material, and supplies will reach a total of $3,103,244,000. A suggestive point in connection with the use of all this money is that none of it embraces any direct expenditures by the roads for railway labor, but represents payments to national industries of one kind or another, which have contributed to the expansion of business and to the stimulated employment of our working populace.

MORE OPENINGS FOR OUR COLLEGE-TRAINED MEN

WHY WASTE time at college? Why not jump right into business after leaving high school? These are some of the questions that have been aimed at the seekers of college training; and, repeatedly, these aspiring youths have been warned that they would fall behind in winning a competence in the world of business.

Now comes the National Industrial Conference Board with the announcement that American Big Business will need during the next seven years more than 200,000 new leaders! This organization tells us that the demand is growing in the United States for trained young men; and the question is from where are these qualified men to come? The situation is but little understood; and yet the lack may place us at a grave disadvantage by 1930. This is because our technical schools have now enrolled only about 50,000 students, and they are turning out something like 9,000 graduates annually.

It seems that less than 20 per cent. of the men who now plan and administer the productive work of the nation are graduates of any college; and yet there is a rapidly increasing need for administrative and technical ability in practically all lines of activity. This is especially true of our manufacturing and our mechanical industries. There is a growing demand for graduates of engineering schools who will enter upon work which will fit them for positions of administrative as well as technical responsibility.

As the National Industrial Conference Board emphasizes: "The preparatory schools can perform a great service to industry as well as to the students by properly evaluating the advantages of an engineering course and by guiding toward the engineering schools the boys who have, or in whom can be developed, an interest in producing things."

THE TOLL FIRE EXACTS OF PETROLEUM PRODUCERS

PERHAPS NONE of us now living would ever be seriously incommoded because of a shortage of petroleum from the domestic oil fields, but, even so, we may be obliged to pay more for fuel of this sort because of wastefulness.

One of the greatest wasters is fire. According to the United States Department of the Interior, the yearly fire bill among petroleum producers in this country attains to staggering figures. Statistics compiled by engineers of the Bureau of Mines, covering a period of ten years and including only the more extensive fires, indicate total losses of approximately 13,000,000 barrels of oil and more than 5,000,000,000 cubic feet of natural gas.

In the three years from 1918 to 1920, inclusive, fires in storage farms, pipe-line systems, and refineries occasioned an aggregate loss of about $14,000,000. A single oil-tank fire at Beaumont, Tex., in July, 1922, was responsible for damage involving quite $2,000,000; while oil fires throughout the country generally in the same month led to injuries or losses totaling $3,000,000.

While the majority of field fires are probably due to lightning, still many of them may be traced directly to carelessness or lack of suitable preventive measures. The oil producer's fire hazards are of a different nature from those of the pipe-line or refining company; but, whether producer or refiner, it is pointed out that it is practicable to lessen the risks by the exercise of certain simple or established precautions. Among these are means by which storage tanks can be fitted with gas-tight tops and by which any vapors given off may be carried away in pipes either to a neighboring gasoline plant or to a place of discharge where the gases will not constitute a menace. The experts are not in favor of erecting lightning rods on or near the oil tanks, because it is extremely undesirable

to encourage electrical discharges and sparks in the neighborhood of oil-laden reservoirs.

To the general public the subject is interesting mainly because it emphasizes why we should be watchful both of the bung and the spigot of an industry which plays so important a part in our daily life.

MERCURY-VAPOR BOILERS PROVE PRACTICABLE

OFF AND on for a number of years the mercury-vapor boiler has been talked about and put to a test upon a laboratory scale. Now, thanks to the inventive genius of Dr. W. L. EMMET of the General Electric Company, and to the substantial support of that great organization, the mercury-vapor boiler has been brought to a point where it has seemingly made good on a commercial scale.

The new boilers are installed at the Dutch Point plant of the Hartford Electric Light Company, and it is expected that these power generators will be able in the near future to reduce by fully 50 per cent. the cost of fuel for the driving of the associate steam turbines.

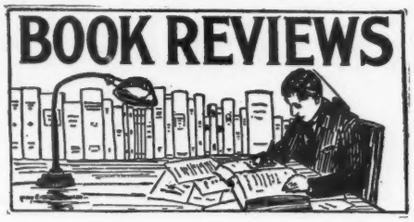
The *New York Herald,* in a special dispatch, declares: "The boilers carry about 3,500 kilowatts of the Hartford load, which is hardly of sufficient quantity to have any effect on the total cost of power produced by the Hartford company. The steam boilers producing most of the power will be replaced by the new mercury boilers; but years will be required before the new process can be expected to reflect on the operating costs of public utilities."

PAPER FROM HARDWOOD

THE Newton Falls Paper Company owned by the McGraw-Hill Company, has taken a big leap forward in paper making by the perfecting of a process for the manufacture of book and catalog paper of the highest grades from hardwood. Book, bond, ledger, offset, and cover paper is now being turned out. Beech, maple, and birch have so far been mostly used for the purpose, but it is believed that other hard woods can be utilized as well. The company has a large area of hardwood timber land, with standing trees enough to last from 75 to 100 years. It is to be hoped that the supply will be maintained by careful arboriculture.

Under the auspices of the Sullivan County Chapter of the Joseph A. Holmes Safety Association, in coöperation with the United States Bureau of Mines, more than 20,000 people from all parts of the Hoosier coal belt gathered recently for a big first-aid and mine-rescue meet. Over a score of government mine-rescue men directed the work, and 26 teams from different mines were entered in competition. The first prize was won by Team No. 7, of Clinton, Ind., with the high average of 99½ per cent. efficiency.

We should be grateful to any of our readers if they would send to the editorial office, 11 Broadway, New York City, copies of the October and the November, 1923, issues of Compressed Air Magazine for which they have no further use.



THE PREVENTION OF VIBRATION AND NOISE, by Alec B. Eason. An illustrated work of 163 pages, published by the Oxford University Press, New York and London. Price, $5.00.

THE PURPOSE of this book is to show in what directions steps can be taken to get rid of troublesome vibrations caused by machinery of various sorts, such as electrical motors, generators, transformers, automobiles, locomotives, gas engines, etc., in short to prevent as far as practicable noises of this description. Human susceptibility to vibrations is extremely variable: one individual may be especially sensitive to them while another, working in the same room, may deny their existence.

As may be realized, the subject is an important one, and the author has aimed to give in this one volume the information collected by him upon methods of preventing vibration; to relate facts learned in the course of investigations; and to indicate where fuller information concerning these facts may be found. As Mr. Eason puts it: "When looking up references, one realizes what an immense amount of information exists, and how often the same facts are published almost simultaneously by different writers in different journals. Those interested often fail to see it and waste time and money repeating tests which have already been made."

The work should be very useful to young engineers and architects, who are studying vibration and its effects, and to experienced engineers, architects, and builders who, even though they may be fully informed, will find it convenient to have the facts collected within the compass of a single volume.

HOW TO THINK IN BUSINESS, by Matthew Thompson McClure, Professor of Philosophy, University of Illinois. A volume of 173 pages, published by McGraw-Hill Book Company, New York. Price, $2.00.

AS HAS been aptly said, "Reading good business books is good business." In this volume, Professor McClure has tried to give helpful information to every man who wants to make the most effective use of his mental equipment. The illustrative material has been drawn almost exclusively from the field of practical business experience; and the presentation is in a form which makes the suggestions readily available to the busy man of affairs.

The business book of today, with its summary of other men's experiences, its valuable findings, and its helpful practical advice, is playing a large part in the development of American industry; and *How to Think in Business* should therefore find a place not only in the large reference libraries, maintained by leading business houses and industrial corporations for the use of their staffs, but also on the shelf of the enterprising young executive who will find that his advancement is in proportion to his personal knowledge and grasp of the subjects relating to his work.

BETHLEHEM MAYARI PIG IRON, a Natural Nickel-Chromium Alloy Iron for Making High-Grade Castings. Publication No. 26, containing numerous illustrations and tables, produced by the Bethlehem Steel Company, Bethlehem, Pa. Price, $1.00.

THIS handbook, of 103 pages, has been published primarily for the benefit of the foundryman, inasmuch as Mayari Iron is said to fit into practically any mixture a foundryman may find it necessary to employ for his particular purpose. To quote: "In the early days of the production of Mayari Iron it was used almost entirely in the manufacture of steel, because of the valuable properties it gave to the alloy steels thus produced. Some of the Mayari Iron, however, was used in foundry work, and in the castings resulting from the mixture several special qualities were noticed, namely, the smooth appearance of the surface, the closeness of the grain structure, and the strength of thin fins on the castings. These features led to further experiments and tests, and it was found that the special elements, nickel and chromium, in the Mayari Pig Iron—which are so important in the making of special steels—had a remarkable effect in producing exceptionally high-grade castings."

The book also contains two articles, entitled *Cupola Practice with Nickel-Chromium Pig Iron* and *Metallurgy of Iron with Nickel-Chromium,* by Dr. Richard Moldenke, an international authority on foundry work.

MONEY, a comprehensive work of 409 pages, by William Trufant Foster and Waddill Catchings, published by Houghton Mifflin Company, Cambridge, Mass. Price, $3.50.

THIS WORK is Volume No. 2 of a series of books on economics, published by the Pollak Foundation for Economic Research, and deals with a subject that touches the interests of more people more frequently than any other. It is also the subject that has most to do with labor problems, unemployment, profiteering, and business cycles; and it is from this angle that the authors are discussing the characteristics of a monetary economy.

As the writers have expressed it: "An understanding of the part that money plays in the world is prerequisite to a solution of the most critical problems of our day, national and international. Such an understanding requires a knowledge of those attributes of money economy that make it essentially different from a barter economy. With attention fixed on goods rather than on money, there is danger of overlooking those aspects of modern production and distribution, particularly the unbalancing of supply and demand, that have most to do with the periodic ups and downs of business."

But in their book, *Money,* Messrs. Foster and Catchings are attempting to lay but the groundwork for further studies of this vital topic, and thereby "to hasten the day when money—with its purchasing power protected against excessive fluctuations—will do more to promote and less to hinder the work of the world."

CANADA MAKES NOVEL USE OF AEROPLANES

IN THE development of commercial flying since the war, aircraft have been put to many unusual and peculiar uses. Some of these have been of the stunt variety; others have been for the purpose of advertising; and on various occasions aircraft have proved of great value in emergencies.

Perhaps for the first time in the history of commercial flying, an aeroplane has been employed in connection with elections in an isolated and sparsely settled district. The Ontario provincial elections, which took place in June of this year, presented a big transportation problem to the officials responsible for the work in the remoter parts of the province. Owing to the very late spring, the ground and rivers were almost impassable, and the task of getting the officials to James Bay in time to compile the necessary voters' list and to appoint returning officers, scrutineers, etc., was one that appeared extremely difficult to solve.

The Dominion government's experience with aircraft has been so satisfactory, however, that arrangements were concluded to do the necessary transporting by air. The first trip was made on May 23 from the Laurentide Air Station at Remi, situated just north of Moonbeam on the National Transcontinental Railroad, to Moose Factory on James Bay. The official in charge—a judge—made all the needful preparations for compiling the voters' list, for selecting the returning officers, etc.; and this work, together with the journey, was accomplished in about 5 hours as against 22 days for the previous trip made to that region by the same justice in the usual way. On June 6 a second trip was undertaken to appoint the officials required in connection with the voting. On this occasion a police magistrate was in charge, and he carried on not only the election work, but, for the first time in history, held court at James Bay.

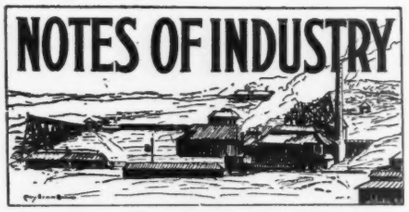
Upon arrival at Moose Post it was found that two Indians had been arrested for assault and violation of the Ontario Temperance Act. The normal procedure in the case of such offenses committed in the north is for a patrol of the Royal Canadian Mounted Police to proceed to the point where the offenders are and then to escort them to Cochrane, where they are tried and sentenced. This practice, which has been unavoidable in the past, naturally involved considerable expense and hardship upon the officers selected for the work. Upon this occasion, however, the police magistrate tried the prisoners, fined them, collected the fines, and returned upon schedule time. A third flight into the James Bay district saw the elections of these "farthest-north" polls completed.

These particular incidents have brought out an important phase of aircraft operations. The transportation of prisoners, or in some cases of magistrates and of police officials through the north country has always been most difficult, and during certain seasons of the year quite impossible. The records of the Royal Canadian Mounted Police tell of hundreds of instances where men have risked their lives in getting prisoners because of the hardships endured in getting over the ground.

The Ontario government has also made use of every available flying machine for forest-fire-prevention service, and in consequence the authorities have been in possession of accurate and prompt information as to the fire situation at all times. This results in a much more effective use of the fire-fighting personnel than when the survey is made from ground stations.

The following instance will serve to illustrate the value of aircraft for this purpose. One day, at noon, severe fires were reported about 200 miles from the aircraft base on Lake Nipigon. A machine left Lake Nipigon at once for the scene of the fires, and by five o'clock that afternoon, after a careful survey, the aviator forwarded an account from the nearest telegraph station to which he had flown after completing his observations. This report, which covered the situation over the entire fire area, was very thorough and could not have been made out by a ground party in less than several weeks. By that time the information would, of course, have been useless.

The Province of Quebec has also made extensive use of aircraft. Several machines have been operating in the St. Maurice Valley and have done much useful work in spotting fires, in reporting upon their progress, and in controlling the fire-prevention activities on the ground.



"Ammite" is a new explosive, said by the manufacturers, the Atlas Powder Company, Wilmington, Del., to possess all the advantages of dynamite in strength, velocity, water resistance, sensitiveness, and stability with the important additional advantages of being non-freezing and of not causing headaches. It is made in six grades as to strength: 75, 60, 50, 40, 35, and 30 per cent.

The Union Cold Storage Company, under the control of the Vestey Brothers, is not only the biggest meat distributor in the British Empire but it also has the largest cold-storage facilities in the Kingdom.

A recent German patent covers a new kind of soap which is to contain no alkali but to which a large quantity of sugar is added—the resulting product being a soap with exceptional cleansing qualities and having a mild effect on the garments washed with it. The inventor insists that alkali is a deterrent, and he believes that soap would be even more efficient with an alcohol content. He therefore adds 40 per cent. sugar, and suggests that a higher percentage would be even better. We would want to keep soap of this kind away from the children.

Realizing the possibilities of dehydration, exhaustive studies are being made of the subject throughout Germany today; and there are now nineteen plants in that country devoted to the dessication of vegetables, especially potatoes, and fruits. Some of the earlier establishments have been reconstructed, while others have been entirely replaced by greatly improved installations.

A celebration was held recently at Fort Wayne, Ind., to mark the completion of the millionth gasoline pump manufactured by S. F. Bowser & Company. There were present 1,800 employees and executives, and crowds of citizens. The first pump was built 38 years ago; and the millionth pump is not to be sold but will be set up as a permanent monument—presumably to await the billionth.

Birmingham, England, is said to be the largest jewelry manufacturing center in the world.

Roger Babson estimates that the 1922 cut of lumber for the entire country was 35,000,000,000 board feet, divided about equally between the Southern and the Pacific States. This is enough lumber to encircle the earth, at the equator, with a boardwalk one inch thick and 266 feet wide.

The Philippine Islands, so we are told, offer an enormous field for the expansion of the sugar industry. They have an area of approximately 115,000 square miles, and much of it is suitable for sugar-cane growing.

New sources of food gelatine have been developed in Lower California, as we learn from Consul Leighton Hope. Great quantities of seaweed are being treated and reduced to a very clear and nearly tasteless gelatine of high quality.

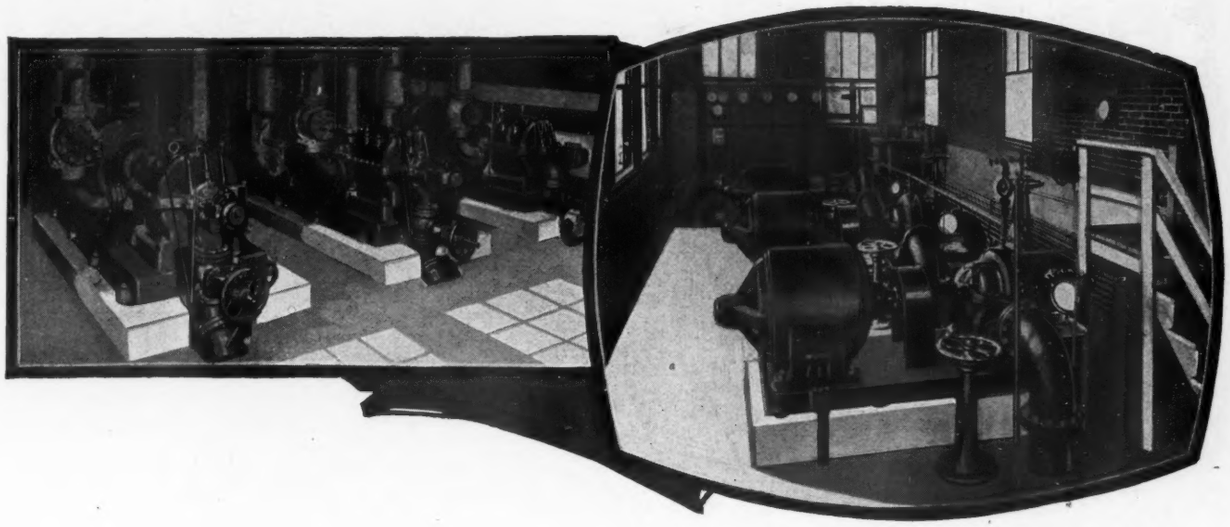
The use of Maxim silencers for compressors is growing, especially where quiet must be assured. Four such installations were recently made in the Altoona school district; the Hartford Connecticut Trust Company had two compressors, used for sewage disposal, equipped with as many silencers; and the Eastman Kodak Company, of Rochester, N. Y., had one 10-inch and one 6-inch silencer placed on vacuum-pump discharges.

A novel method of increasing crop yield comes to us from Japan. We learn through the *American Fertilizer* that a material named "promoloid" is used which is based upon colloidal silicate of aluminum. It is not a manure, but an agent which stimulates the growth of vegetables; improves their taste, color, and form; and enables the realization of unusually fine crops. Promoloid is sold in liquid form, and must be diluted with water before being applied to the soil.

With the completion of the Southern Pacific, California will have a direct rail connection with Mexico City.

An Efficient Cameron Installation

At The St. Louis Coke and Iron Company



In their modern plant there are three multi-stage turbine driven pumps on boiler feed service. Each delivers 350 gallons per minute against 600 ft. head.

The three motor-driven, double-suction, volute pumps shown in the left-hand illustration are used for general plant service, each pump delivering 3000 gallons per minute against 150 ft. head.

Each of these Cameron pumps was designed for the service conditions for which it was sold; every detail of construction was developed in accordance with modern engineering theory and practice.

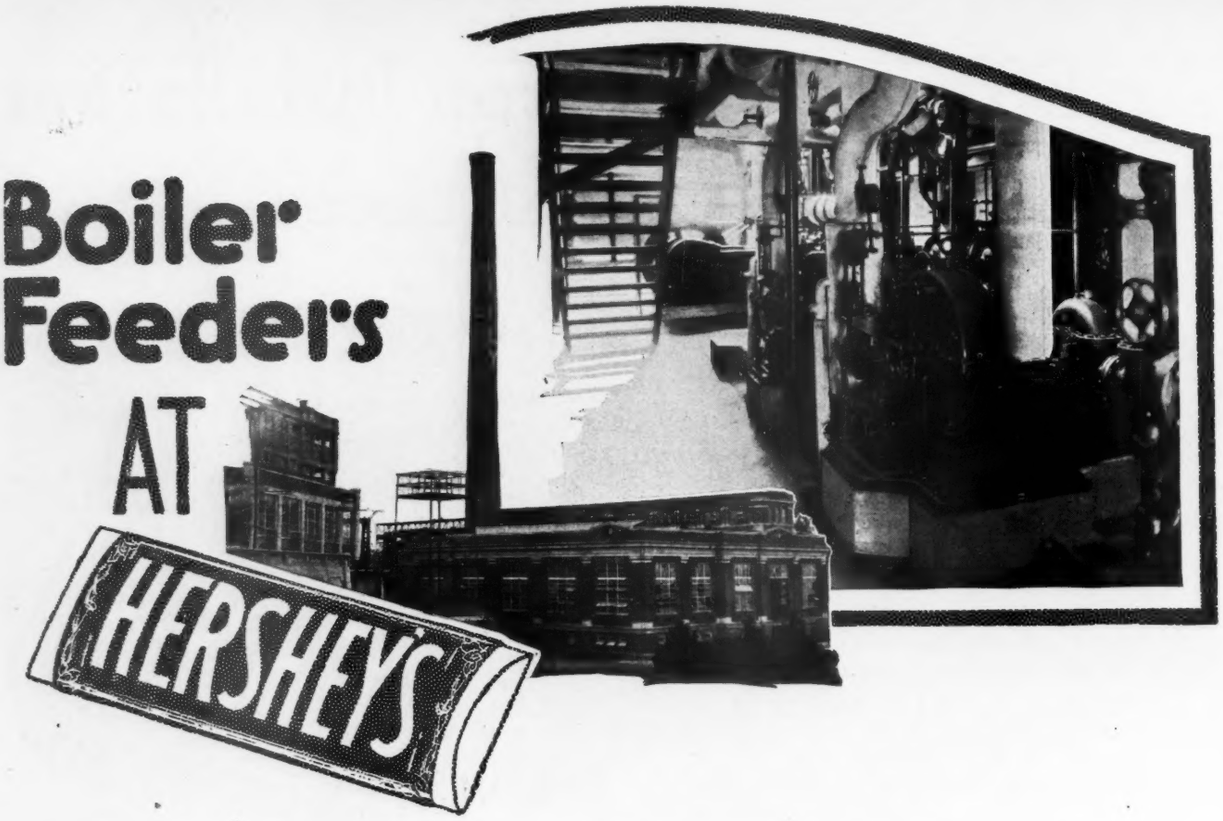
Cameron Engineers have successfully solved pumping problems for every industry. Their counsel and co-operation are always at your disposal without expense or obligation. Consultation with Cameron Engineers results in an installation which will give absolute satisfaction.

Complete set of Bulletins on request.

A. S. Cameron Steam Pump Works, 11 Broadway, New York

Offices in all principal domestic and foreign cities

Cameron Pumps



Are Driven by TERRY Turbines

To meet the enormous consumption of milk chocolate, the Hershey Chocolate Company requires 45 acres of floor space, 18,000 cows and a large, modernly equipped, up-to-date power plant.

Like many other nationally known concerns, they have installed Terry Turbines to drive their boiler feed pumps and, to quote Mr. Ezra F. Hershey: "They have been working entirely satisfactorily, and have never given us any trouble or cause for complaint."

Power-plant owners and operators have found by experience that uninterrupted service is assured when they use Terry Turbines to drive such essential auxiliaries as boiler feed pumps, condenser pumps, stokers, forced and induced draft fans and exciters.

Surely you can make no mistake by selecting that which the majority of engineers have unqualifiedly approved—a TERRY TURBINE.

A Terry engineer will be glad to tell you more about Terry Turbines and their application to your individual needs. T-900

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.
Offices in Principal Cities

The TERRY TURBINE

As a matter of reciprocal business courtesy help trace results

The Shaft Sinking "Jackhamer"—DDR-13

The DDR-13, the largest of the "Jackhamers," is essentially a deep hole machine. Shaft sinking and deep hole quarry work demands just such a machine—hard hitting, fast drilling and economical.

The DDR-13 weighs 70 lbs. and every ounce is essential weight. This drill has the maximum speed and ease of operation without losing the portability feature.

"JACKHAMER"—What it is:

The "Jackhamer" is a superior type of self-rotating hand hammer rock drill. It has established an enviable reputation for fast drilling, low upkeep cost and durability.

The "Jackhamer" is now made in five weights. The three largest ones are made for use with steam or compressed air. These may also be equipped with or without arrangement for feeding water as well as air through the hollow piston and drill steel to the bottom of the drill hole to allay the dust and remove the cuttings.

Although "Jackhamers" are principally used for down-hole drilling, and for service where the machine may be held in the operator's hand, mountings are made for the three larger sizes when they are used for drifting or tunnelling work.

"JACKHAMER"—What it does:

BAR-33: General light drilling, block holes, timber hitches, foundation bolt holes, various small drilling jobs around industrial plants.

BBR-13: Used principally with twisted auger steel for drilling soft iron ores and coal.

BCR-430: General all around rock drilling in mines, quarries, contracts, etc.

DCR-23: For shaft sinking and deeper holes and heavier work than that to which the BCR-430 is applied.

DDR-13: For extra deep holes in very hard rock, shafts, quarries and similar duty.

Bulletin 4046 describing "Jackhamers" completely, will be sent upon request.

INGERSOLL-RAND COMPANY, 11 BROADWAY, NEW YORK

ATLANTA	CLEVELAND	EL PASO	NEW YORK	SAN FRANCISCO
BIRMINGHAM	DALLAS	HOUGHTON	NEW ORLEANS	SALT LAKE CITY
BOSTON	DETROIT	JOPLIN	PHILADELPHIA	SCRANTON
BUFFALO	DENVER	KNOXVILLE	PITTSBURGH	SEATTLE
BUTTE	DULUTH	LOS ANGELES	POTTSVILLE	ST. LOUIS
CHICAGO				WASHINGTON

For Canada refer Canadian Ingersoll-Rand Co., Limited, 260 St. James St., Montreal

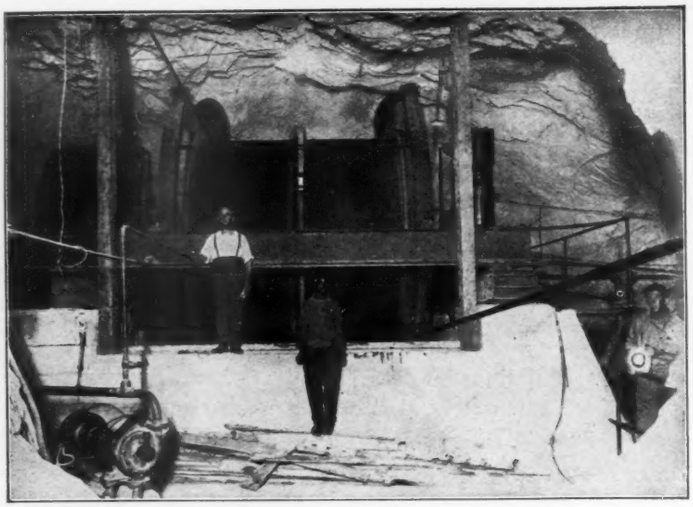
Ingersoll-Rand

280 JD

CEMENT-GUN TRADE MARK

A Recent Report States:

"In South African mines, where the drives pass through ground which is influenced by exposure, to air, the "Cement-Gun" is used extensively for coating the roof and side walls of drives to prevent falls and this has been done even in pump and hoisting engine chambers which were 20 to 30 feet wide by 50 feet long.



Upper view shows a portion of one of the pump chambers referred to; and, at the left, one of the hoisting engine chambers.

"CEMENT-GUNS"
Are Sold in South Africa by
EDWARD L. BATEMAN,
The Corner House,
Johannesburg

N. V. INTERNATIONAL CEMENT GUN CO.
ZEIST, HOLLAND

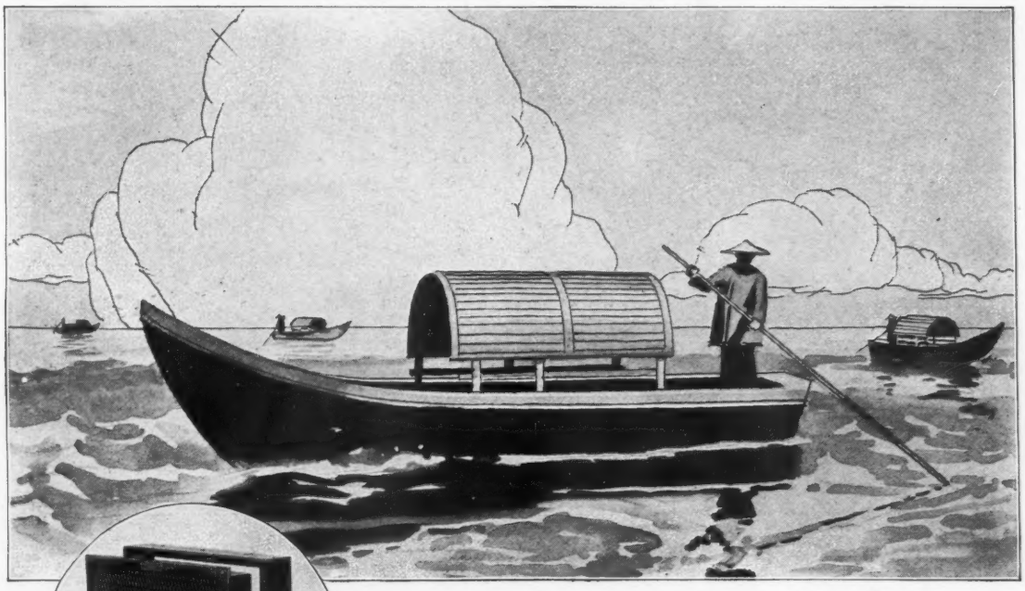
Great Britain
INGERSOLL-RAND CO., Ltd.
165 Queen Victoria St., London, E. C. 4

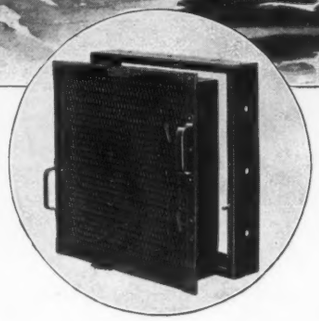
France, Belgium, Spain, Portugal
CIE. INGERSOLL-RAND
33 Rue Reaumur, Paris

For the United States and Its Possessions, Canada and Mexico

CEMENT-GUN COMPANY, Inc., Allentown, Penna., U. S. A.

REED AIR IS CLEAN AIR





Why the Japanese Lacquer on a Sampan

When the Japanese craftsman had an especially valuable object to lacquer he put himself--and his work—aboard a Sampan and sailed out to sea, beyond the reach of dust and dirt.

You cannot take your work out to sea, but we can bring to your work air as clean as an ocean breeze where you want it, when you want it—and 97% pure.

The Reed Air System (Patented) insures clean air ventilation in banks, schools, office buildings and department stores, (where with ordinary systems 2% is charged off annually because of dust contamination) hotels, museums and hospitals. Reed clean air saves re-decorating costs as well as shut down costs on compressors and delicate machinery. Reed air filtration always assures quicker, cleaner drying for paint, entmeling and varnished finishes, besides improving working conditions.

Use the coupon to get the facts on Reed Clean Air. Sold on the *try before you buy plan.*

Let us make this Free Test

Our nearest representative will be glad to make the authoritative E. Vernon Hill Test on your Air conditions. No obligation.

REED AIR FILTER COMPANY, Inc.
Engineering Department
616 Barret Avenue, Louisville, Ky.

Gentlemen: Please send me without obligation your informative folder, "Are You Interested in Clean Air?"

Application.....C.F.M.

.....

Name.....

Address.....

REED AIR FILTER COMPANY, Inc.
616 Barret Avenue, Louisville, Ky. 50 Church Street, New York City

Reed Air

TRADE MARK

filters ALL METAL

Note: SIGN ON THE "REED AIR" DOTTED LINE.....FOR CLEAN AIR AT MINIMUM COST

Ask the hard rock miner

He'll tell you quick as a shot what Commander Air Hose means to him in the flinty face of hard rock going. Flexible, non-kinking, it answers the easy turn of his hand. With extra thick, non-porous cover, more durable than steel, it stands the wear and tear of yanking and hauling. Fine for the miner. Lasting and economical for the boss.

THE B. F. GOODRICH RUBBER COMPANY
Akron, Ohio

Goodrich

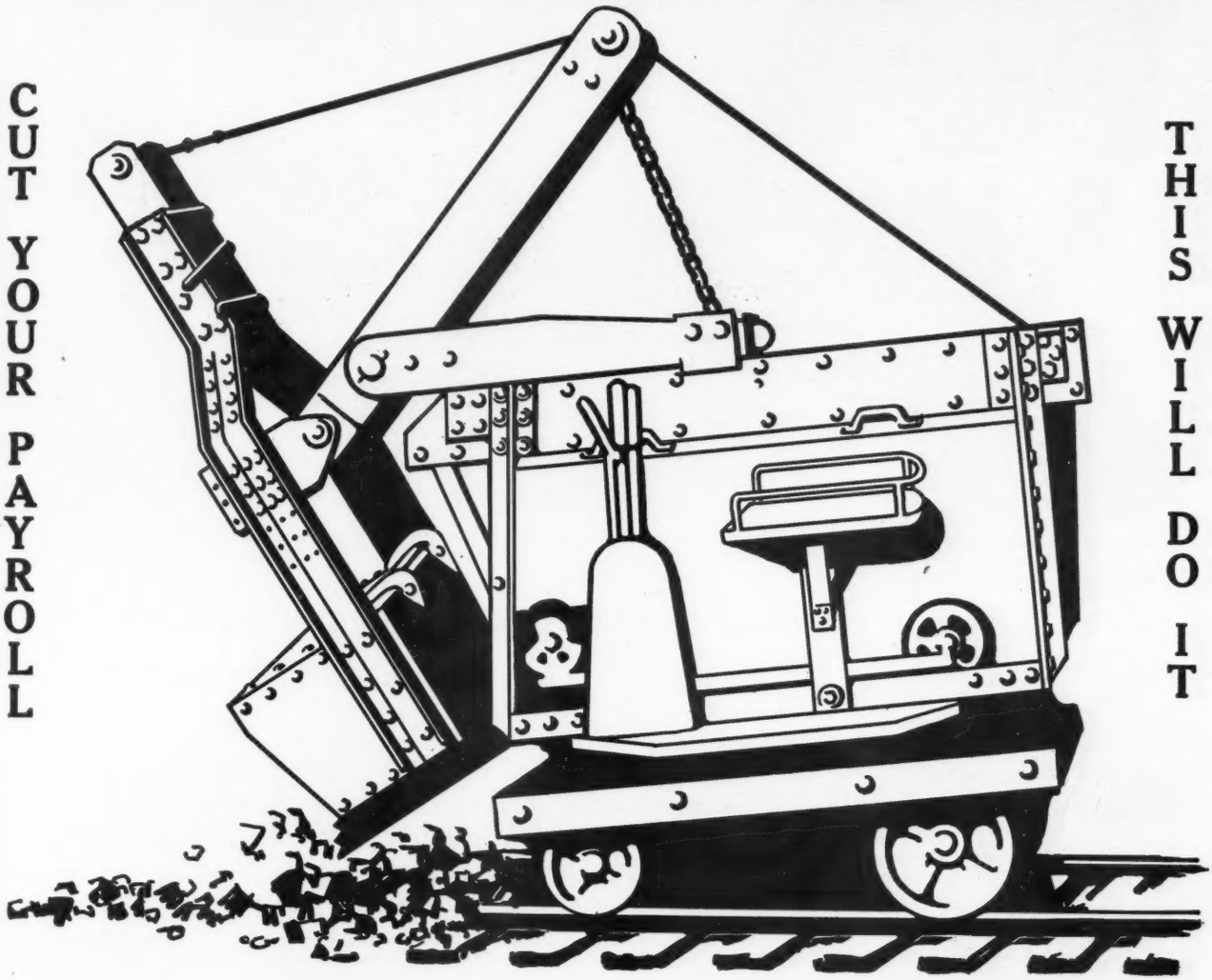
AIR HOSE
COMMANDER
REG. U.S. PAT. OFF.
THE B.F. GOODRICH CO. AKRON, O.

Commander
AIR HOSE
"Best in the Long Run"

As a matter of reciprocal business courtesy help trace results

DOUBLE PRODUCTION

CUT YOUR PAYROLL



THIS WILL DO IT

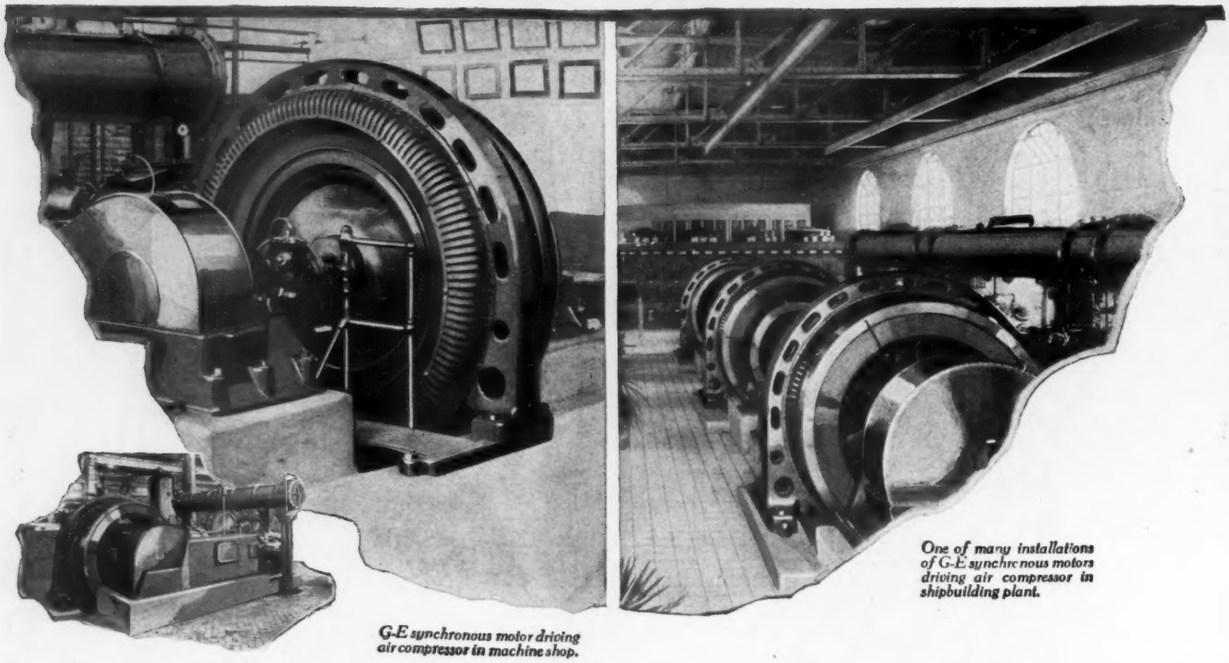
THE HOAR UNDERGROUND SHOVEL

"The greatest piece of shoveling mechanism there is."
"More than doubled production at a total repair cost in four months of $10.58."
"Decreases mucking costs 50 to 75%."

HOAR SHOVEL COMPANY, Inc.

DULUTH, MINNESOTA

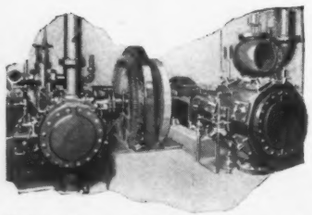
Please aid the Advertiser by mentioning COMPRESSED AIR MAGAZINE *when writing*



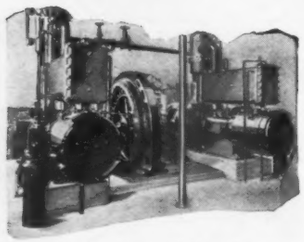
One of many installations of G-E synchronous motors driving air compressor in shipbuilding plant.

G-E synchronous motor driving air compressor in machine shop.

A big electrical industry uses this G-E synchronous motor for driving air compressor.



G-E synchronous motor driving air compressor in automobile factory.



Mining industry also uses G-E synchronous motor drive for air compressors.

G-E Synchronous Motors—*the* Drive for Air Compressors

The general adoption of G-E synchronous motors for this type of drive is acknowledgment of the claims long made for them. In steel mills, railroad shops, shipyards, mines, automobile plants, and other important industries—many air compressors are driven by these dependable, high power factor synchronous motors.

The proved efficiency of G-E synchronous motors—practically the same from full to half load—and falling off only slightly at quarter load—makes them money savers for their users. Designed to operate at unity power factor, they improve the power factor of the system—and with a normal field excitation they continue power factor improvement when underloaded. Due to large air gap, which is five to eight times that of an induction motor, slight bearing wear does not impair the motor's operating characteristics. This is a big point where continuous operation is essential.

A G-E synchronous motor working with a standard air compressor will give uninterrupted service at low cost.

General Electric Company
Schenectady, N. Y.
Sales Offices in all Large Cities

GENERAL ELECTRIC

43B-608

As a matter of reciprocal business courtesy help trace results

Waukesha
TRADE MARK

Standards so high, definite and thoroughly proven as those of the Waukesha Industrial Unit represent a keen manufacturing appreciation not alone of the ordinary everyday demands that are levied on portable power equipment, but also of demands that are unusual.

Today in over fifty different industries, this highly specialized unit is delivering service that stands unequalled. In its rugged power, performance efficiency, and thorough reliability under all conditions, it proves itself day after day an uncommonly good investment.

If your business demands heavy duty motors—your business demands that unit which in dependability and capacity pays the biggest profit over cost. Write for full information.

The WAUKESHA MOTOR CO., WAUKESHA, WISCONSIN

The World's Foremost Builders of Bus, Truck, Tractor and Industrial Motors Exclusively

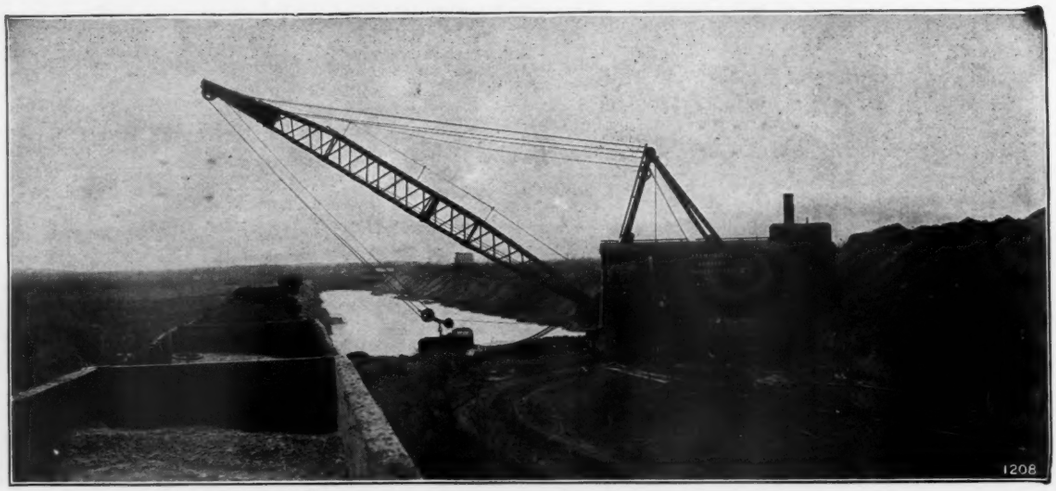
SALES OFFICES:

1824-1825 Aeolian Building
33 West 42nd Street, NEW YORK
Telephone: Longacre 5784

503-505 Capitol Theatre Bldg.
Madison Avenue Side, DETROIT
Telephone: Cadillac 4482

Showing the Industrial Unit and Power Take-off

Is Your Pit Wet?
Is Your Stripping Cost High?
Do You Lose Much Gravel in Deep Pockets?
Do You Carry Too Much Clay or Sand to Your Washer?



The Clem Gravel Co. of Dallas, Texas, Operates Two Bucyrus Draglines in Their Pits

IF YOU SAY "YES" TO ANY OF THE ABOVE QUESTIONS, IT WILL PAY YOU TO INSTALL A BUCYRUS DRAGLINE EXCAVATOR

A dragline will dig as well under water as in the dry.

In many operations it can strip and load from one setting.

Its long reach enables it to pick out streaks of clay and pockets of sand from your deposit and cast them out of the way.

It can follow down deep pockets of gravel, thus effecting big savings and at the same time carry a bank of easy running material ahead.

Its long boom makes it possible to strip in wide cuts with the least possible moves of machine or loading track.

These are but a few of the many advantages of the dragline.

Send for Bulletin G-V and ask for full information on draglines for gravel plants and quarries

Let us tell you more

Bucyrus dragline excavators are built in sizes carrying booms from 35 to 155 feet in length, steam, gasoline or electric.

BUCYRUS

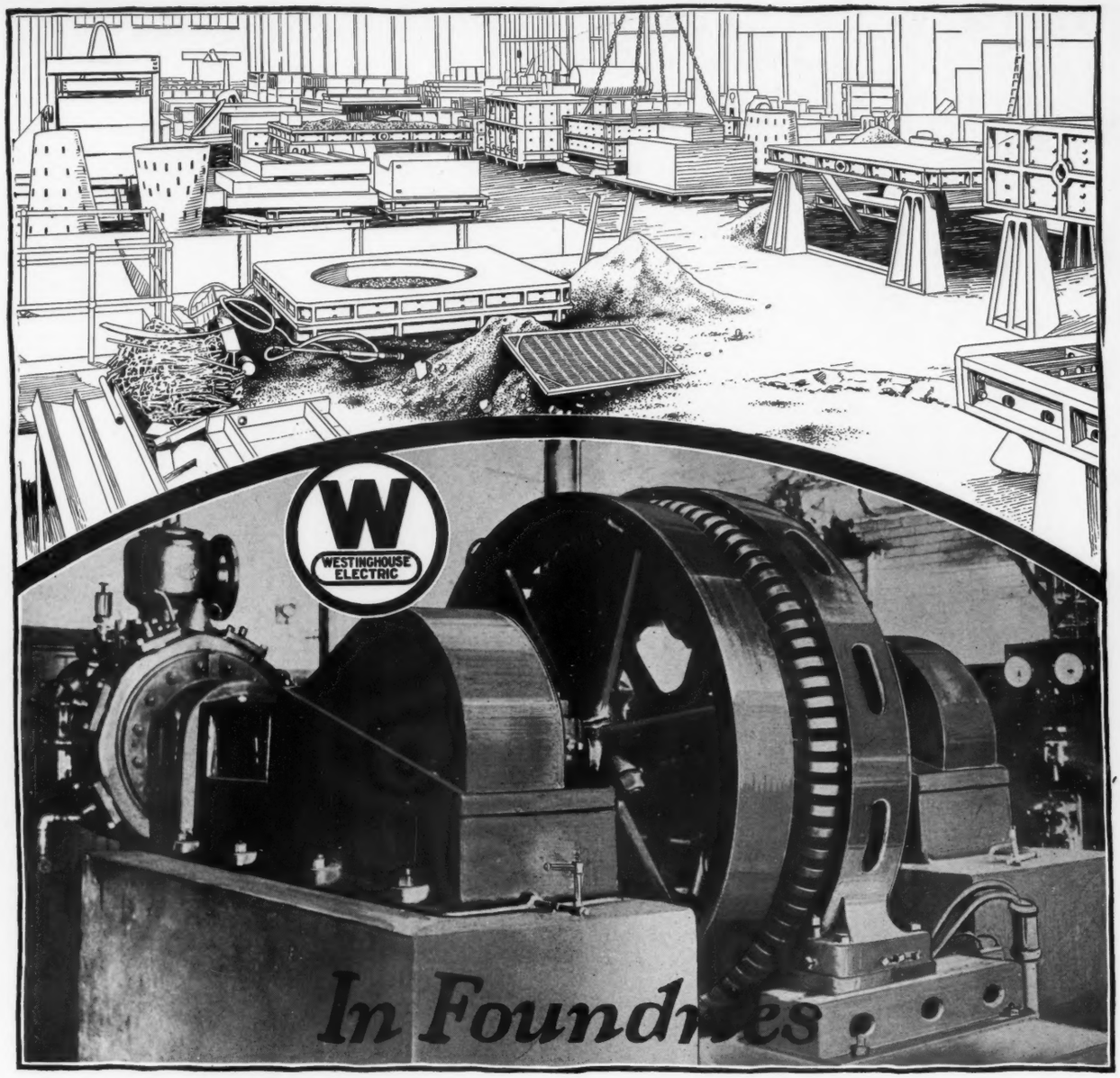
Established in 1880 *A Special Plant Devoted Exclusively to Small Revolving Shovels*

Railroad Type and Revolving Shovels of All Sizes, Dragline Excavators, Trench Excavators, Dipper, Hydraulic and Placer Dredges, Spreader Plows, Wrecking Cranes, Etc.

BUCYRUS COMPANY, SOUTH MILWAUKEE, WIS.

New York Chicago Birmingham San Francisco Portland Denver Tokyo London

536



Compressed air is indispensable to a foundry where steady production is desired.

Air must be available for the chipping hammers, sand blasting machines, furnaces and other foundry operations. The failure of the motor driving the compressor means practically a shut-down.

To assure against loss of production due to motor failure, buy Westinghouse synchronous motors for your air compressor drive. By doing this you prevent serious delay.

Because Westinghouse motors have demonstrated their reliability for a great many years, you will find them in many foundries throughout the country.

Some of the foundries using them are:

McConway-Torley Co., Pittsburgh, Pa.
Keystone Steel Castings Co., Chester, Pa.
National Malleable Castings Co., Chicago, Ill.

Follow in the footsteps of those who have learned from experience. Specify Westinghouse Synchronous motors to the compressor manufacturer.

Westinghouse Electric & Manufacturing Company
East Pittsburgh Pennsylvania
Sales Offices in All Principal Cities of the
United States and Foreign Countries

Westinghouse

"I Never worry about the Air Compressor" Can *you* say as much?

YOUR choice of lubricating oil makes all the difference between an air compressor which gives you years of dependable, safe service, and one that does not.

It took the Vacuum Oil Company years of technical field study of air compressors to determine the formula for the scientifically correct lubricant.

Gargoyle D.T.E. Oil Heavy Medium is the outcome of those studies. It is unanimously endorsed for the lubrication of the air cylinders of air compressors, and assures **reliable** operation.

It is the only oil that air compressor manufacturers unite in recommending. Its rich lubricating qualities permit it to be fed in minimum quantities—a consideration which makes for safety as well as economy.

You can secure supplies of Gargoyle D.T.E. Oil Heavy Medium by writing or telephoning our nearest branch office.

Operating Note

COOLING. Cooling water for cylinder jackets and heads must always be turned on before the air compressor is started. Frequent temperature readings should be made of the cooling water at inlet and outlet. This will indicate any irregularity in the action of the discharge valves. Discharge air temperatures should be regularly reported as any rise in temperature will be an indication of irregularity of operation—i. e., deficient cooling, carbonized discharge valves or a poor piston seal.

GARGOYLE

Lubricating Oils

A grade for each type of service

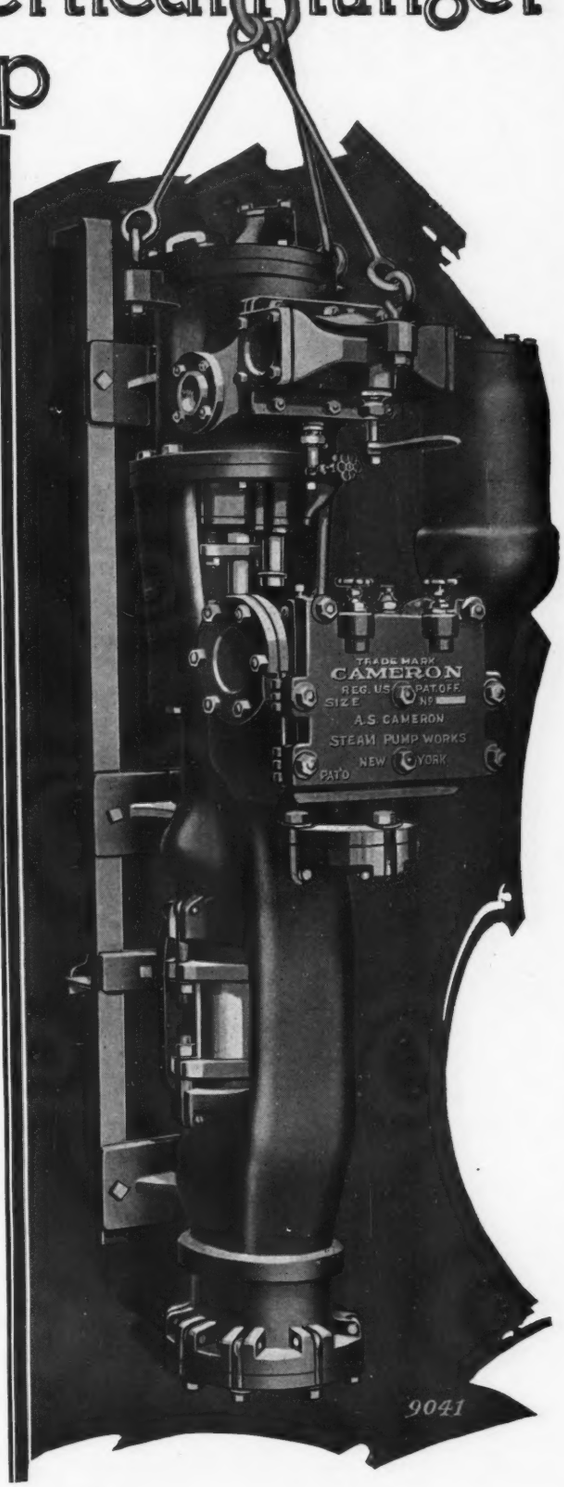
Domestic Branches

New York (Main Office)	Chicago
Boston	St. Louis
Philadelphia	Detroit
Pittsburgh	Indianapolis
Buffalo	Milwaukee
Rochester	Minneapolis
Albany	Des Moines
Oklahoma City	Kansas City, Mo.
	Dallas

VACUUM OIL COMPANY

As a matter of reciprocal business courtesy help trace results

The Cameron Vertical Plunger Sinking Pump



A Rugged Reliable Pump Which Will Handle Gritty, Dirty Water

It requires less space in the shaft than any other pump. There are no exposed parts liable to breakage from blasts or collisions with the side walls. No wearing parts in the water end, except the packing in the stuffing boxes which can be adjusted from the outside.

The Cameron Vertical Sinking Pump is also built in two other types:

The Sectional Pump—designed for mule back haulage, the heaviest piece weighing 300 pounds.

The Prospectors Pump—for shaft sinking and general work where large capacity is not required.

Cameron pumping service stands for reliability and economy combined with simplicity of construction.

Bulletin 7304 on request.

A. S. Cameron Steam Pump Works
11 Broadway, New York
Offices Everywhere

126S

Cameron Pumps

"I didn't know we could get that kind of service from McGraw-Hill"

(*An Actual Incident*)

The Sales Manager and the Advertising Manager were discussing a market problem.

"I wish that we could get some real information about this question," said the Sales Manager.

"We can," said the Advertising Manager, "and I'll get it for you—from the McGraw-Hill Company."

"I didn't know we could get that kind of service from McGraw-Hill," was the surprised reply.

The above is a literal conversation as repeated by the Advertising Manager, who promptly secured the desired information. Which may be indicative of a situation that exists in other quarters.

With fifteen leading engineering and industrial publications, organized editorially and with channels of research, to render leadership thinking and to closely analyze the industries served, McGraw-Hill offers a kind of service that is of inestimable value to those who use it.

This wealth of information, so vitally necessary to maintain and improve publishing standards, need not be buried in the fifteen McGraw-Hill editorial departments nor locked in the findings of trained research men. There is an outlet other than through the editorial pages of McGraw-Hill Publications for the authoritative opinions of nearly one hundred McGraw-Hill editors—for the conclusions of McGraw-Hill investigators who are combing specialized fields of industry.

Whatever this Company collects to serve its readers editorially is available to *any* manufacturer or Advertising Agency who asks to have an individual problem met by individual handling. Editorial opinion, market analyses and statistical data applying to any cross section of industry is ready to be tapped.

Think of McGraw-Hill as a big Industrial Market index file. Use this index file freely.

McGraw-Hill Company, Inc.

Tenth Avenue at Thirty-sixth St., New York, N.Y.

THE PAPERS THAT SERVE and THE MARKETS THEY REACH

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American Machinist
Serving machine shop executives and engineers.

American Machinist—European Edition
Published in London and circulated throughout the countries of Europe and the United Kingdom.

Chemical and Metallurgical Engineering
Serving the chemical engineering industries.

Industrial Engineer
Serving those responsible for the proper operation and maintenance of electrical and associated mechanical equipment in mills and factories.

Power
Serving all those concerned in power plants with the generation and transmission of power.

CONSTRUCTION AND CIVIL ENGINEERING

Engineering News-Record
Serving those directly engaged in the practice of civil engineering or in construction work generally.

MINING

Coal Age
Serving the mining operators and distributors of both bituminous and anthracite coal.

Engineering and Mining Journal-Press
Serving those interested in metal mining, smelting and refining.

TRANSPORTATION

Electric Railway Journal
Serving officials and department heads on roads comprising 98% of the total electric railway industry.

Bus Transportation
Serving those in the bus transportation industry who are associated in engineering, managerial, or general business capacities.

ELECTRICAL

Electrical World
Serving executives and engineers, including those who design, construct, operate, maintain, equip, or finance the great plants that generate or use electrical energy for power, light, heat and transportation.

Electrical Merchandising
Serving those who sell, manage or finance electrical appliances, equipment, supplies or service.

Electrical Retailing
Published in Chicago to supplement the service of Electrical Merchandising among smaller dealers, contractors and non-electrical distributors of electrical goods.

Journal of Electricity
Serving all industries in the western states interested in the economy, efficiency, and convenience of electric power.

EXPORT

Ingenieria Internacional
Serving in all Spanish-speaking countries, engineers, technical and industrial executives in the five major branches of engineering.

ZELNICKER Ever-Tyte PISTON RINGS

NOTICE—PRICES ARE MADE FOR PROMPT ACCEPTANCE; ALL ORDERS ARE ACCEPTED SUBJECT TO DELAY OCCASIONED BY ACCIDENTS, STRIKES, FIRES OR OTHER CAUSES BEYOND OUR CONTROL.

DANIEL JEFFREY & SONS
INCORPORATED
BOILER, TANK and STRUCTURAL STEEL WORKS

DANIEL JEFFREY, PRESIDENT
ROBT. W. JEFFREY, VICE-PRESIDENT
DANIEL F. JEFFREY, JR., TREASURER
NEILL P. JEFFREY, SECRETARY

JEANERETTE, LA.,
5/30/23

Ever-Tyte Piston Ring Division,
Walter A.Zelnicker Supply Co.,
St.Louis,Mo.

Gentlemen:-

It is with pleasure that we wish to advise that we are still obtaining perfect satisfaction with our crude oil engines, after installing your EVER-TYTE rings in same some 18 months ago. We have these rings installed in the following engines:

1 - Chicago Pneumatic Engine Compressor 50 h.p.
2 -.St. Mary Oil Engine Co. 30 h.p. each

Judging from our past experience we feel that we could not do without rings such as the EVER-TYTE have proven to be.

Yours very truly,

DANIEL JEFFREY & SONS, INC.
N.P. Jeffrey

The Jeffreys Obtained Perfect Satisfaction and Feel That They Could Not Get Along Without Ever-Tytes.

If you are getting less than Perfect Satisfaction from the rings now in your Engines, Pumps, Compressors, Ice Machines, Autos, Trucks, Tractors, Locomotives, Boats, order Ever-Tytes On Trial with Satisfaction Guaranteed.

EVER-TYTE PISTON RING DIVISION
Walter A. Zelnicker Supply Co.
ST. LOUIS

Cement, Mill & Quarry

A MAGAZINE

published in the interest of those producing Cement, Gypsum, Lime, Crushed Stone, Gravel, Sand and other non-metallic minerals.

Enterprising business men in over 6,000 operating plants read this paper regularly. It keeps them in touch with current industrial activities, and assists them in finding new methods of greater production to take care of the ever increasing demand.

IT WILL SERVE YOUR INTERESTS TOO.
Write today for complete information.

International Trade Press Inc. CHICAGO

Engineering World
Highway Engineer and Contractor
Concrete Products
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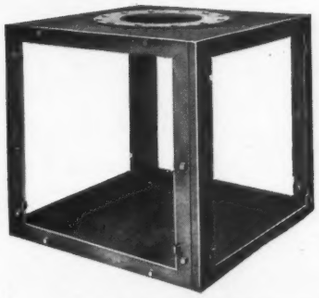
Directory Cement, Gypsum and Lime Manufacturers

Cement, Mill & Quarry
Monadnock Block
Chicago

As a matter of reciprocal business courtesy help trace results

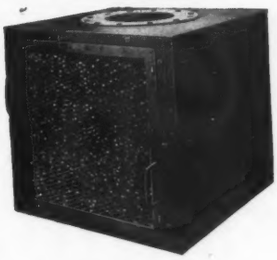
You Don't Add Valve Grinding Compound to Your Compressor Lubricating Oil!

Midwest Unit Cell and Frame



Frames for Type B Filter

Type B is built up with any number of unit cells desired, on frames fastened together as shown.



Type B Filter

Type B with one or more unit cells. Any number of such assembled filters may be used, depending on conditions.

What of the dirt and dust your compressors suck in with every stroke of their pistons?

There is plenty of dust and dirt in your plant air. Put a clean handkerchief across the air intake of your compressors and convince yourself!

That dirt and dust combine with the lubricating oil to form an effective grinding paste that wears valves and cylinders. Look at your low pressure cylinders!

Why not catch all dust and dirt before they do damage?

Clean Midwest Filtered Air

will add years to the life of your compressors and pneumatic equipment.

Read What This User Says:—

Mr. Clifford H. Leighton, Chief Engineer of the Saco-Lowell Shops, Newton, Massachusetts, in discussing the Midwest Air Filters installed in their plant says:

> "Even when conditions were supposed to be quite clean about the plant, it was surprising to see the large amount of dirt and dust still collected by the filter. In our plant our old compressors would probably not have been replaced at this time if we had used air filters during the many years these compressors were in operation.
>
> "The two old compressors having a total rated capacity of 1050 cubic feet per minute are now unable to deliver even 750 per minute without running at over speed. The reason for this is that during the years these compressors were in service, dirt and dust had caused a continual grinding action so that the capacity of the compressors was greatly reduced.
>
> "Another thing noticed since using these filters is the small amount of lubricating oil required."

Midwest Air Filters are simple, fool proof and low in first cost. Maintenance costs are practically nil.

An investigation will cost you nothing but will probably pay you dividends. Start YOURS now!

See Our Exhibit at the Power Show, Booth 307

We will show a complete line of MIDWEST AIR FILTERS, including the working installations. Do not neglect to visit our booth. In the meantime ask Dept. F-5 to send our new catalog.

Some attractive sales territories are still open.
Write if interested.

MIDWEST AIR FILTERS

MIDWEST CANADA LIMITED
83 CRAIG ST. WEST
MONTREAL CANADA

INCORPORATED
100 EAST 45TH STREET
NEW YORK CITY
OFFICES IN PRINCIPAL CITIES

MIDWEST AIR FILTERS PACIFIC, INC.
953 MONADNOCK BUILDING
SAN FRANCISCO, CAL.

THE TOOL-OM-ETER

shows instantly the flow of air in a pipe or hose, measures the actual consumption of any tool, machine or process operated by Compressed Air, eliminates guesswork and permits maintenance of economy in tools throughout their life. Fully described in Bulletin "6-A."

THE NEW JERSEY BLOWER or "TRANSFORM AIR"

Transforms a small volume of Compressed Air into a large volume of low pressure air. Bulletin "B" gives full information.

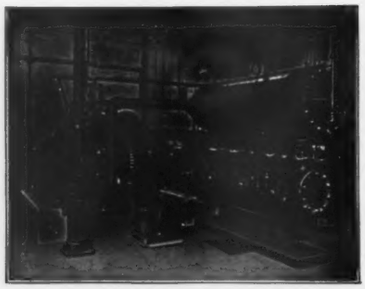
The "DriAir" Separates and Automatically

discharges Water from Compressed Air lines. Delivers clean, dry air to pneumatic tools and other equipment. Bulletin "D A."

Foreign Agents—American Trading Co., Tokyo, Yokohama.
Ingersoll-Rand Co., London, Paris, Montreal, Johannesburg, Melbourne.

NEW JERSEY METER COMPANY, PLAINFIELD, N. J.

Ultimately a Bury "Universal" 3-Cylinder, 2 Stage, Variable Volume Air Compressor. Why Not Install One Now?



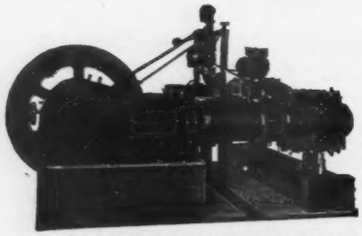
The largest American firms use the "BURY" air compressor — because of its **proven dependability.** Back of the "BURY" lies 20 years of research, development and conscientious service to users.
If you are interested in the "last word" in air compressor improvements, send for the new "BURY" Compressor Booklet 407.

Do It Now!

The Patented Bury 'Universal' Pyramid Box PlateValves are noiseless in operation and have 50% greater area than any other compressor valve.

Durable as the Pyramids

Silent as the Sphinx



"CLASS CCS"

Bury Universal type, Duplex, Compound, Steam driven. Built in capacities from 450 to 3000 cubic feet per minute.

All Sizes, All Types for All Pressures to Meet Any Engineering Requirements

Bury Compressor Co., 1101 West 17th St., Erie, Pa.

POWELL VALVES

For Air Compressor Lines

WHITE STAR DASH POT CHECK VALVE

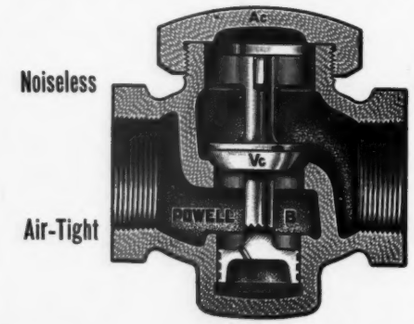


Fig. 95

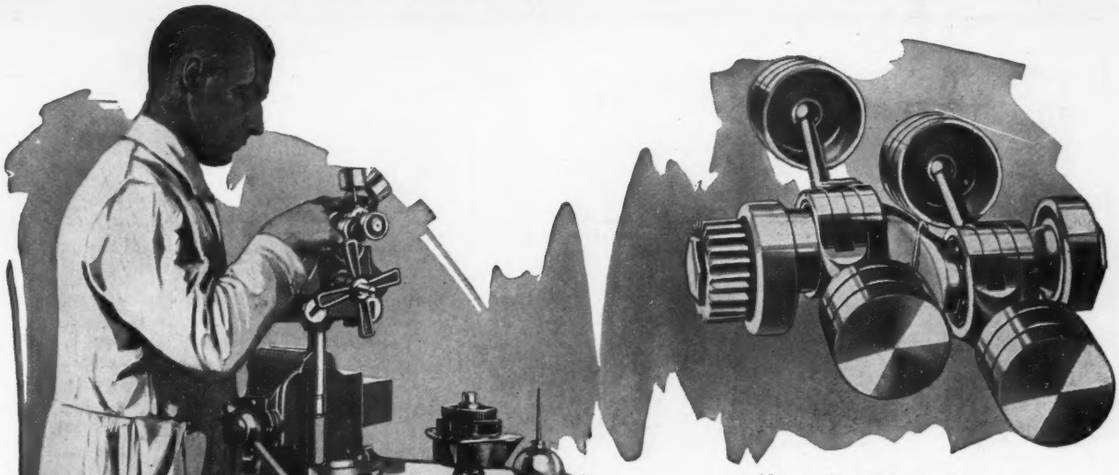
No pounding on the diaphragm, Non-Corrosive Powellium Disc seats itself automatically

NO SPRINGS TO GET OUT OF ORDER

Write for Descriptive Information

THE WM. POWELL CO.
1310 Draper Street
CINCINNATI, OHIO

As a matter of reciprocal business courtesy help trace results

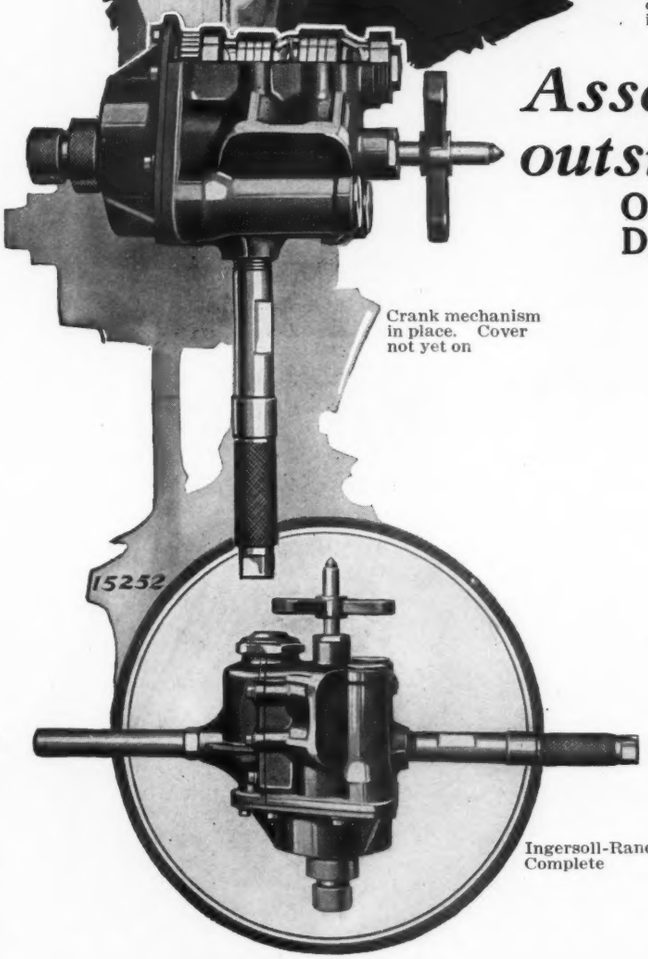


Above—Complete crank mechanism assembled outside of drill

Left—Inserting crank mechanism in drill case

Assembly of Crank Parts outside of drill case—

Only Ingersoll-Rand Pneumatic Drills Have This Labor-Saving Feature



Crank mechanism in place. Cover not yet on

Ingersoll-Rand Drill Complete

This feature saves time in assembling and assures the work being properly done. It avoids lost time from working on small machine parts in awkward, inaccessible places. A man soon uses up valuable time fumbling with bolts, nuts and straps through a handhole barely big enough for a thumb and finger, and then is not certain if the work is properly done! Ingersoll-Rand construction eliminates such troubles.

Or, a complete crank assembly can be kept on hand and quickly substituted in a drill so that the machine can be immediately put back in service without loss of more than a few minutes' time.

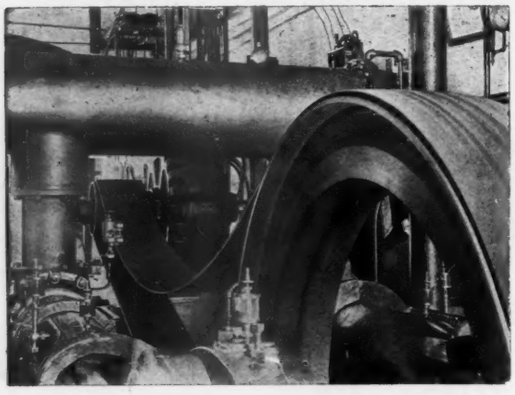
Ask any tool-room man about what a time and labor saver this is. Or ask us for a complete description of the Penumatic Drills.

INGERSOLL-RAND COMPANY
11 Broadway, New York

Offices in all Principal Domestic and Foreign Cities

For Canada, refer Canadian Ingersoll-Rand Company, Limited 260 St. James Street, Montreal, Quebec

Ingersoll-Rand



A 12" leather laminated belt driving a 75-82 Rand compressor. Pulley diameters 5' and 14", on 13 ft. centers. Treated with Cling-Surface since 1910. Runs 24 inches slack under 75 H.P. load, yet—NO SLIP!

Freed from strain of tension!

What happens when a belt is freed from tension,—when it is run slack like the one pictured above?

Gone is the friction caused by the usual tightening strain; friction that adds to the normal load on the engine, friction that causes bearings to run hot, friction that injures the belt itself. No longer does the belt suffer from these ill effects of tension. No longer do machinery and production suffer from dissipated power, broken belts and lacings, prolonged shutdowns from interrupted transmission.

No belts in your plant are worked harder than your compressor belts. There is variation in tension at every stroke, even under constant load,—and a constant load is rare. It is usually all off or all on, minute by minute, taxing the belts to the utmost. It is a comfort to have steady pulling, healthy working belts; to *know* that they will not fail you when needed most.

The slack belt drive today is not one of theory. It was, back in '96, when we first pioneered this method of belt transmission, but today the correctness of such procedure is deep rooted in facts. Yet, advantageous as slack-running belts have proved themselves, only through the use of Cling-Surface can full economies of operation be obtained in this manner. No treatment in the past 27 years has allowed belts to run slack under full loads without slipping with the results that Cling-Surface gives.

Yes, you are safe in trying Cling-Surface where other methods have failed. Morever, the fact that Cling-Surface may be obtained in three different densities assures you that we can meet your individual operating conditions exactly. The heavy or medium densities are best suited for compressor work, unless conditions are very dusty.

May we send you a tin—on trial? We ask no payment until Cling-Surface has proved our claims, and its worth to your belts.

Clip and Mail NOW

CLING-SURFACE COMPANY

1051 NIAGARA ST. BUFFALO, N. Y.

Gentlemen—You've got me interested in your Belt Treatment.

Send us a trial 3 or 5 gallon tin of [ ] Light

Name: ..... [ ] Medium

Company: ..... [ ] Heavy

Address: ..... CLING-SURFACE

(Check square [ ] for consistency desired) [ ] Bar

3 Gal. Tin, $3.40 per Gal.; 5 Gal. Tin, $3.25 per Gal.

$5,000

FOR THE remarkably low price of $5,000.00, f.o.b. Denver, Colorado, you can get all this standard machinery for an efficient 15 to 20-ton prospect mill:

1—3x3 Grizzly
1—Primary Jaw Crusher
1—Ore bin gate (rack and pinion type)
1—Ore Feeder
1—SR Feeder S-p e e d Control
1—3x3 Dewco Ball Mill
1—2" Centrifugal Pump
1—Dorr Classifier
1—4 cell, 4 ft. Brown Flotation Machine
1—F l o t a t i o n t y p e Blower
1—Deister Overstrom Pilot Table
1—Deister Overstrom Concentrate Table
1—Oil Feeder

Complete foundation plans and general arrangement mill drawing furnished.

Delivery on short notice. Write today for detailed information.

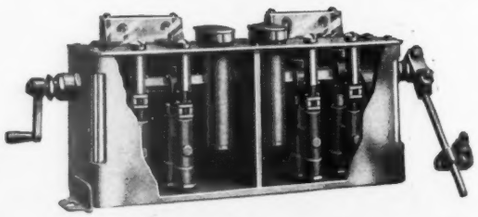
The Stearns-Roger Mfg. Co.

DENVER, COLORADO

Engineers Manufacturers Contractors

MANZEL

Two-Compartment Oil Pump



Ideal for Lubricating Air Compressor Cylinders

Perfect economy and satisfaction is obtained by lubricating air compressor cylinders with the "Manzel" Two-Compartment Oil Pump.

The divided reservoir allows the use of heavy oil for lubricating the steam cylinder and a lighter oil for the air cylinder. Each feed is regulated independently. It automatically puts the right amount of oil in the right place at the right time.

Eliminates the danger of explosions in the air cylinder caused by accumulated oil deposits which result from the use of too much oil; saves the cylinder valves and cuts oil bills from 30 to 60%.

Can be furnished in various capacities, with any number of feeds in each compartment; ratchet or rotary drive.

Write for Catalog No. 423

MANZEL BROTHERS COMPANY

277-279 Babcock Street, Buffalo, N. Y.

As a matter of reciprocal business courtesy help trace results

If You Look Carefully Into

TRADE MARK

"PALMETTO"

REG U S PAT OFFICE

you will find it superior to other packings—because—

MATERIALS: It is made only of the first grade of asbestos fibre that does not require a vegetable substance to give it tensile strength; it is therefore entirely heat resisting.

LUBRICATION: While most packings are merely dipped into lubricant when completed, Palmetto has its lubricant forced hot under pressure into each single strand before braiding.

CONSTRUCTION: Palmetto is not wrapped and cemented together, but braided up layer upon layer, giving it great structural strength—cut open a piece of Palmetto and you will understand.

Free working sample to prove quality

STATE SIZE DESIRED

GREENE, TWEED & CO.

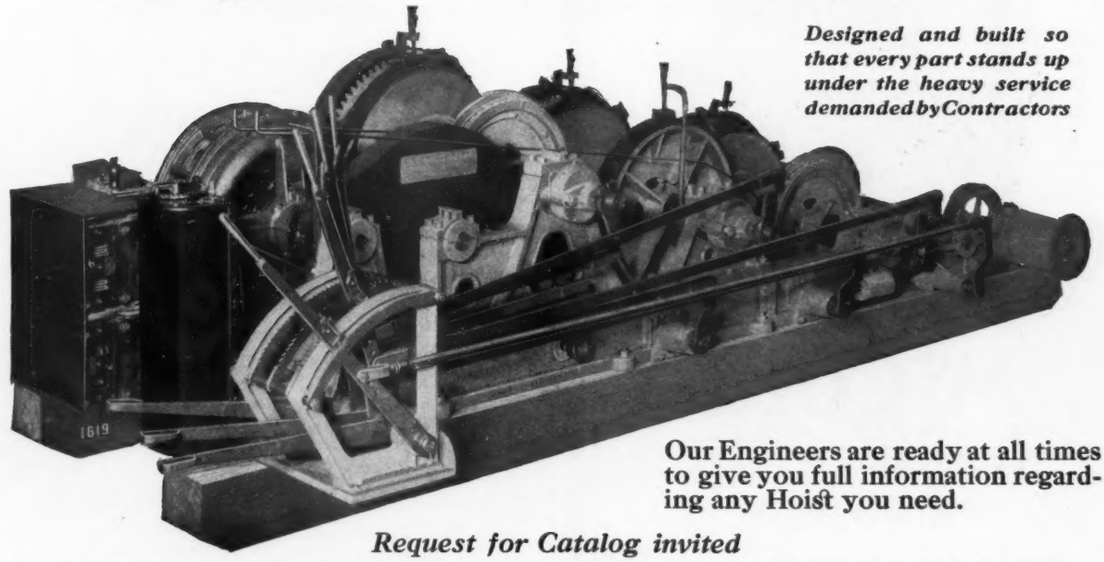
Sole Manufacturers

109 Duane St., New York

LIDGERWOOD HOISTS

STEAM ELECTRIC GASOLINE

Built in types and sizes to meet every hoisting duty in the contracting field.



Designed and built so that every part stands up under the heavy service demanded by Contractors

Our Engineers are ready at all times to give you full information regarding any Hoist you need.

Request for Catalog invited

LIDGERWOOD MFG. CO., 96 Liberty St., New York

Chicago Cleveland Detroit Pittsburgh Philadelphia Los Angeles Seattle
London, Eng. Sao Paulo, Brazil Apartado 812, Mexico

McCORD

Force Feed Lubricators

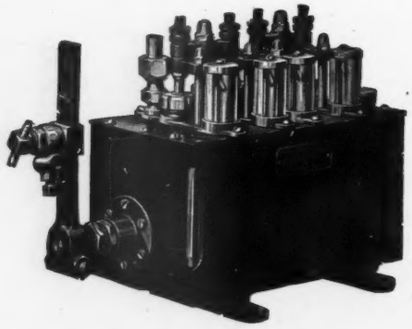
for all Types of Compressors

Air and ammonia compressor operation requires that an exact and right amount of oil be fed at all times, not a drop too much or a drop too little. For this exacting service McCord lubricators have proven most satisfactory, and in many cases buyers of compressors specify McCord lubricators to the manufacturer.

The positive sight feed and ball check pump are two of many superior points, another is that each pump unit is individually adjustable, and removable without interference with any other working part.

Special steel sleeves and fittings can be furnished for ammonia compressors.

A double compartment pump can be furnished when it is desired to use two grades of oil.



Write for Catalog

Mc Cord
RADIATOR & MFG. CO.
LUBRICATOR DIVISION

DETROIT, MICH.

Manufacturers also of McCord and McKim Gaskets, McCord Automobile Radiators

Serves as Crane or Steam Shovel

For unloading and storing your coal and other bulk materials—ore, ashes, etc.; for moving heavy machinery around the plant; for loading scrap with a magnet—USE YOUR ERIE AS A LOCOMOTIVE CRANE.

Then where you have cellar excavating to do, or grading for a plant extension, or any other kind of excavating—**your ERIE serves as a powerful steam shovel.** Easily changed over in a few hours, by any ordinary mechanic.

You get the use of two machines at the cost of one—you are ready for any kind of material handling or excavating. The **ERIE'S** unusual speed and reliability will show you surprisingly low costs. Investigate for yourself. Our Bulletin V-16 gives full details—sent gladly on request.

ERIE STEAM SHOVEL CO., Erie, Pa., U. S. A.
Incorporated 1883: Formerly Ball Engine Co.
Builders of ERIE Steam Shovels, Locomotive Cranes, Railway Ditchers

ERIE Locomotive Cranes

If there is one thing to learn about lubrication

it is that good **lubrication pays.** No machine is so good but that proper attention to lubrication and the use of the right lubricant, makes it better.

You pay more for

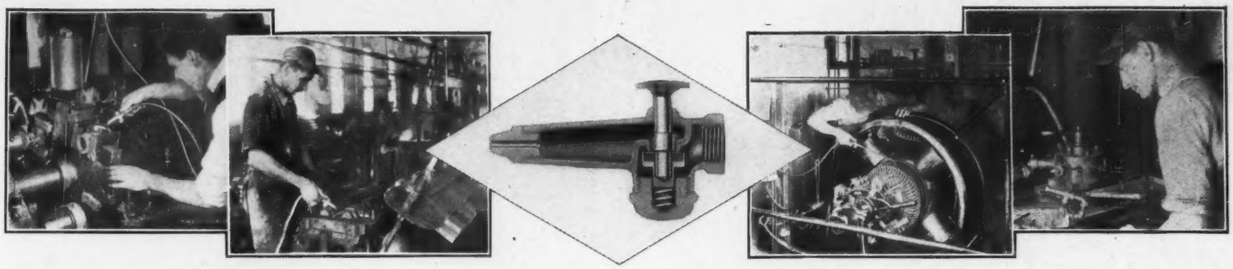
Albany Grease
Registered U. S. Patent Office

a pure tallow lubricating compound, but it costs you less. FOR YOU USE LESS GREASE. No drip—No waste —No deterioration.

SEE FOR YOURSELF how true this is on any bearing in your plant. Get a trial can from your dealer or send for a free sample.

ADAM COOK'S SONS
708-710 Washington Street, N. Y.

All Men Know It — Knowing Men Use It



Chase dirt with this handy air gun

Jenkins Air Gun is light and handy—press the button and it gives a quick blast of air for removing loose dirt, lint, dust, shavings, and the like. It saves time and promotes better work. Fitted with a Jenkins Renewable Disc which prevents air waste, because a perfect contact with the seat is formed when the gun is closed.

30 DAYS TRIAL

We will be glad to send you without obligation a ¼ inch air gun for 30 days trial.

JENKINS BROS.

80 White Street, New York — 133 No. Seventh St., Philadelphia
524 Atlantic Avenue, Boston — 646 Washington Blvd., Chicago

Jenkins Valves

SINCE 1864

FRANCE
METALLIC PACKING

For Any Pressure

AIR, GAS, STEAM OR AMMONIA

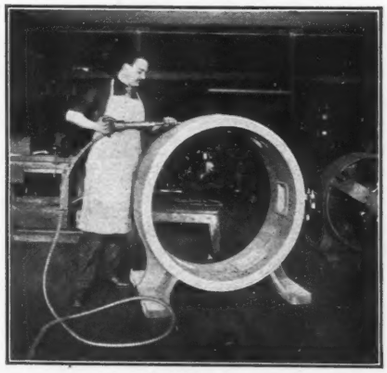
It is furnished on approval and guaranteed to give satisfaction. It reduces friction to the minimum and saves the rod. It will last from five to twenty years.

Send for Catalog and List of Users

FRANCE PACKING CO.
6512 Tacony Street
Philadelphia, Pa.

Branch Offices in Principal Cities

Sprague Steel Armored Air Hose



Sprague Flexible Steel Armored Air Hose Used With Chipper

Sprague Flexible Steel Armored Air Hose is ideal for foundry use. It is covered with an interlocking flexible steel cover and can be dragged over rough floors, castings, etc., without injury. It is extremely flexible, and will not kink or burst. A trial will convince you that its greatly increased life more than offsets its slightly increased cost.

Write for Pamphlet No. B-3567

General Electric Company
Merchandise Department
Bridgeport, Connecticut

GENERAL ELECTRIC

498-201

Expect a lot of the Engine?

Expect plenty of air-pressure through long and little-tended hose-lines? Wish the job onto this engine.

Got to have never-failing compression with only Ignatz Prjzscmka to give the power-plant an occasional look? Put it up to a Hercules.

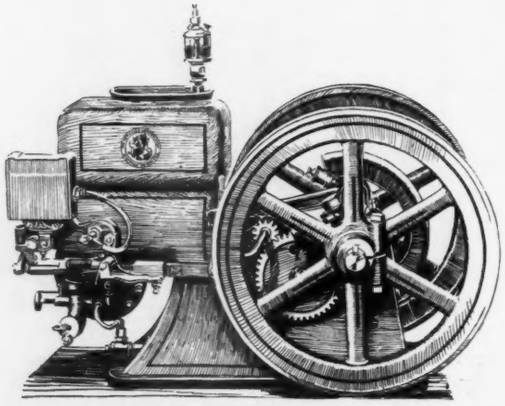
Need an outfit that can be hustled from place to place on six minutes' notice? You've got it right here. . . .

The HERCULES will come through

Men have bought this engine for service as hard as any you will ever expect of one . . . and never found it on the pay-roll yet.

Any Hercules runs on little fuel, with nearly no special care, and stands up to its work without running up repair bills. Whenever you want the evidence, we will deliver plenty.

The Hercules Corporation
Engine Division D
Evansville, Indiana



HERCULES

Made in seven models, from 1½ to 12 h.p., specially equipped when required for every kind of heavy duty industrial service.

Greater Lubricating Efficiency---Lower Lubricating Cost

follows the use of Keystone Grease No. 6. Won't exhaust with the air—even under the most difficult conditions Keystone Grease No. 6 keeps pressure uniform and eliminates shutdowns. Let us give you the full facts.

No. KEYSTONE 6
GREASE
The Master Lubricant
TRADE MARK REG. U.S. PAT. OFF.

The Keystone Lubricating Co.
Executive Office and Works, Philadelphia
ESTABLISHED 1884
New York, Boston, Pittsburgh, Chicago, Detroit, St. Louis, Denver San Francisco, Minneapolis, Montgomery, Kansas City Memphis, Omaha
Agencies in Principal Countries Throughout the World

More tons per man—at less cost!

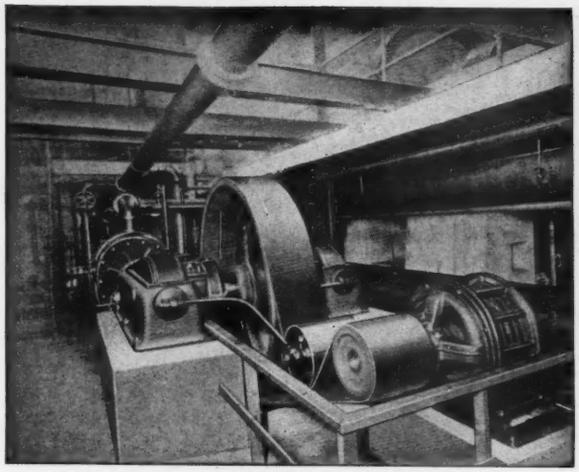
Time and money is saved with the Shuveloder in tunnels, drifts, crosscuts and stopes.

Write for Catalogue 4-B

Lake Superior Loader Co.
DULUTH, MINNESOTA

Speeds up work
Shuveloder
"The mechanical mucker"

As a matter of reciprocal business courtesy help trace results



A Short Belt Drive

Like this one

tests the capacity of any belt—but this "Flintstone" Leather Belt meets the requirements with entire satisfaction, under heavy variable load.

EDWARD R. LADEW CO., Inc.
29 MURRAY ST., NEW YORK

The ERIE Unloader

NEW STYLE

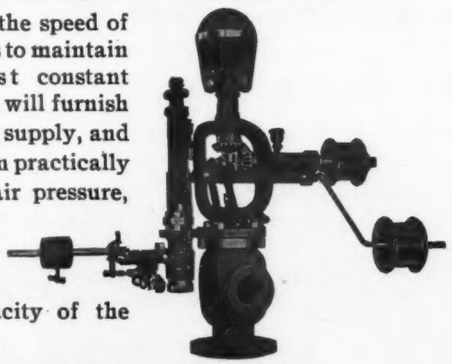
For Single, Duplex and Multiple Stage Steam, Belt or Electric Driven Air Compressors

Maintains practically a constant air pressure, whatever the requirement. Completely unloads and loads Compressor without shock or strain.

ERIE Compressor Governor

For Single and Duplex Steam Actuated Compressors

Governs the speed of Compressors to maintain the slowest constant speed which will furnish any required supply, and will maintain practically a constant air pressure, whatever the requirement if within the capacity of the Compressor.



Circulars on application to

JARECKI MANUFACTURING CO.
ERIE, PENNA.

SAVES TIME, MONEY, AND LABOR

Copyright 1923, by The Goodyear Tire & Rubber Co., Inc.

GOODYEAR AIR HOSE saves money because it lasts longer than any less scientifically designed hose. It has a tube made from a greatly improved compound to resist the action of stray oil or lubricant. The body of Goodyear Air Hose is built stout and strong, so that it carries high, pulsating pressures without weakening. A tough, rugged cover protects this hose from the abrasion common in most kinds of air tool work.

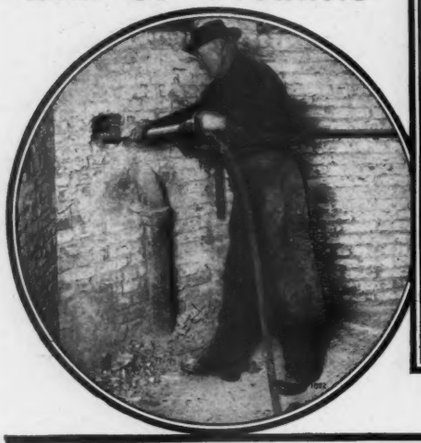
Time is saved by Goodyear Air Hose because it is light, non-kinking, and easily handled. It may be had in continuous lengths, eliminating the bother of connections. And because it is air-tight and trouble-free, tool operators are not distracted by frequent delays for repairs.

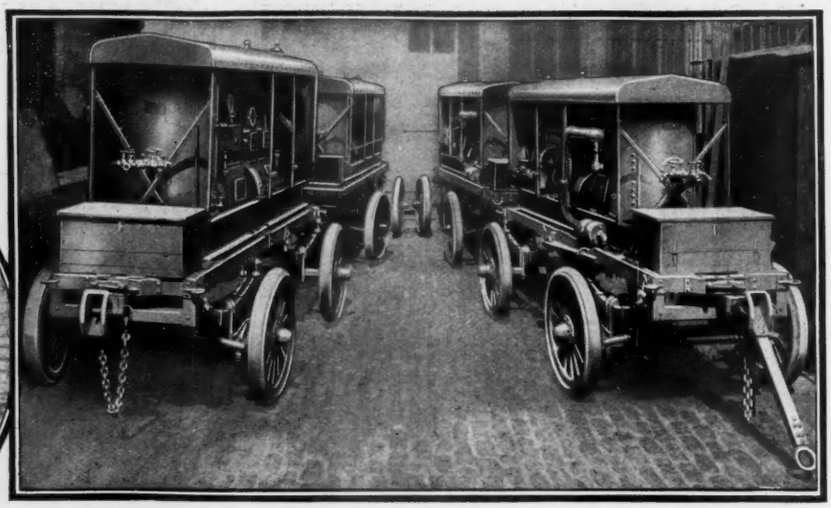
Goodyear Air Hose is so resilient and rugged that it returns to shape though pinched or flattened. Ask your dealer for it. Or write direct to Goodyear, Akron, Ohio, or Los Angeles, California, for information.

Goodyear Means Good Wear

GOODYEAR
AIR HOSE

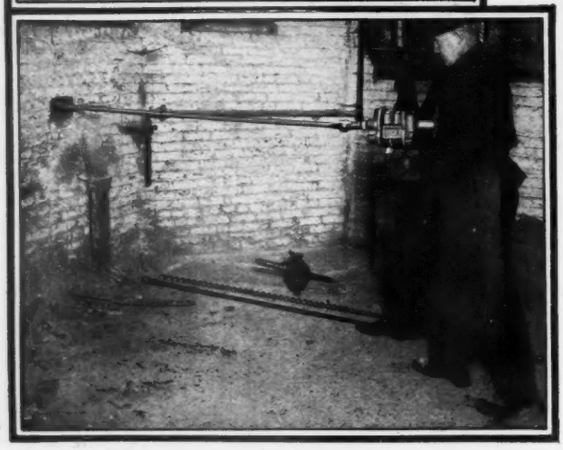
Installing Service Conduits with CP Products





Four CP Class P2-DGL Air Compressors mounted on solid rubber-tired trailers. Quickly hauled to the job by motor truck. Used by large public service company, Brooklyn, N. Y.

Boyer Chipping Hammer, in apartment basement, cutting out brick preparatory to initial drilling operation—the first step toward installing electric light service conduits.



Little Giant Air Drill drilling from cellar to curb preparatory to installing service conduits in apartment building.

USING a Chicago Pneumatic Class P2-DGL Air Compressor mounted on a solid rubber-tired trailer and truck-hauling it to the job, a prominent New York public utilities company supplies dependable air power to a Boyer Chipping Hammer and a Little Giant Air Drill for installing electric service conduits in apartment buildings.

This method obviates breaking flags or excavating, by cutting through foundation walls and drilling holes from cellars to curb, thus demonstrating the wide utility of CP Products.

The service costs vary according to conditions encountered, but the average monthly saving per service on 800 installations has been reported to be $7.85, a total monthly saving of $6,280.00 or $75,360.00 annually. How much can CP products save for you?

The compressor operating the hammer and drill, is but one of four CP Class P2-DGL Portable Gasoline Engine Driven Air Compressors used by the foregoing company.

This type CP Compressor is equipped with Simplate valves, Auto-Pneumatic Throttle and other economy features. Also, furnished mounted on steel truck, or in semi-portable type for mounting on motor truck. Capacities, 128, 160 and 210 cu. ft. per minute.

Address nearest Branch for Bulletin 790 and complete details regarding Boyer Hammers and Little Giant Air Drills for installing service conduits.

Chicago Pneumatic Tool Company

Chicago Pneumatic Building • 6 East 44th Street • New York

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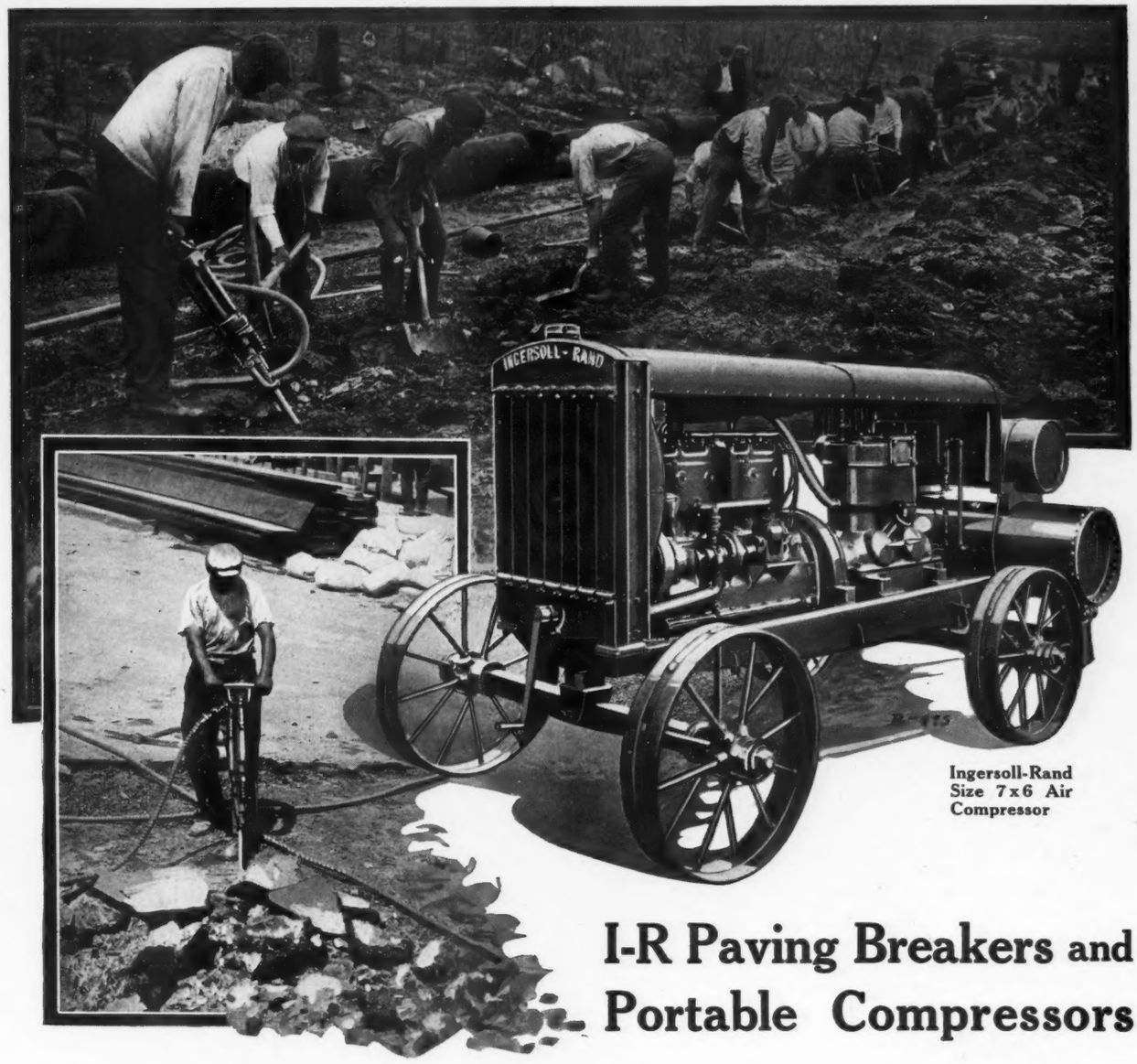

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